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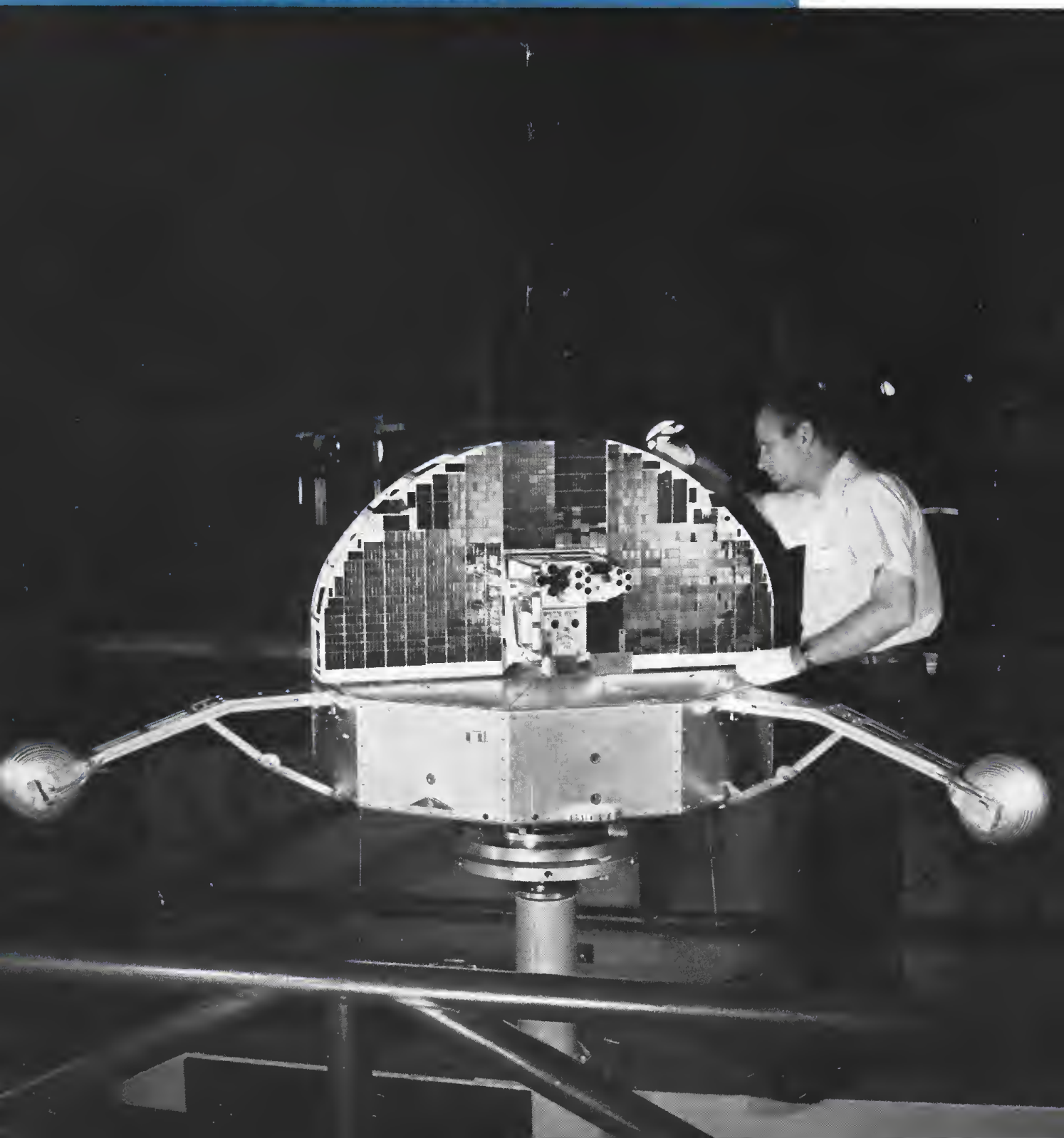
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March 26, 1962

U. S. Begins Laser Weapons Programs

NASA/Ball Brothers OSO-1 Satellite





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AEROSPACE CALENDAR

Apr. 3-4—Seventh Annual Business Aircraft Safety Seminar, Flight Safety Foundation, Jack Tar Hotel, San Francisco, Calif.

Apr. 3-5—Launch Vehicles Structures and Materials Conference, American Rocket Society, Ramada Inn, Phoenix, Ariz.

Apr. 3-6—National Aeronautic Meeting (including production forum), Society of Automotive Engineers, Hotel Commodore, New York, N. Y.

Apr. 9-12—33rd Annual Scientific Meeting, Aerospace Medical Assn., Chalfonte-Haddon Hall, Atlantic City, N. J.

Apr. 10-12—Second Symposium on The Plasma Sheath—Its Effect Upon Re-entry Communication and Detection, New England Mutual Hall, Boston. Sponsor: AF Cambridge Research Laboratories.

Apr. 11-13—Southwestern Conference and Electronics Show, Institute of Radio Engineers, Rice Hotel, Houston, Tex.

Apr. 11-13—Annual Technical Meeting and Equipment Exposition, Institute of Environmental Sciences, Sheraton Chicago Hotel, Chicago, Ill.

Apr. 12-13—Eighth Annual Heat Transfer Conference, Oklahoma State University, Stillwater, Okla.

Apr. 13—Government Contracts Symposium, National Assn. of Professional Contracts Administrators, Ambassador Hotel, Los Angeles, Calif.

Apr. 14—American Society for Metals 14th Annual Purdue Symposium, Purdue University, West Lafayette, Ind.

Apr. 16-18—Second Conference on Kinetics

(Continued on page 7)

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March 26, 1962

Vol. 76, No. 13

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AEROSPACE CALENDAR

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Equilibria, and Performance of High Temperature Systems University of California, Los Angeles, Calif Sponsor Western States Section/Combustion Institute

Apr. 16-18—Second International Flight Test Instrumentation Symposium College of Aeronautics, Cranfield, England

Apr. 16-18—Aerospace Systems Reliability Symposium, Institute of the Aerospace Sciences, Salt Lake City, Utah

Apr. 19—Eastern Regional Meeting, Institute of Navigation Shoreham Hotel, Washington, D C

Apr. 24-26—Polytechnic Institute of Brooklyn's Symposium on the Mathematical Theory of Automata United Engineering Center, New York, N Y

Apr. 25-29—Western Space Age Industries and Engineering Exposition Cow Palace, San Francisco, Calif

Apr. 26-27—Quarterly Regional Meeting, Assn of Local Transport Airlines, Hilton Inn, Atlanta, Ga

Apr. 29-May 8—Hanover Air Show, Hanover, Germany

Apr. 30-May 1—Annual Meeting, National Aeronautical Services Assn., Sheraton Hotel, Washington, D C

Apr. 30-May 2—Meeting on Manned Space Flight, Institute of the Aerospace Sciences, Hotel Chase, St Louis, Mo

May 1-3—Spring Joint Computer Conference Fairmont Hotel, San Francisco

May 1-3—Biologistics for Space Systems Symposium Biltmore Hotel, Dayton, Ohio Sponsor Aerospace Medical Research Laboratories Aeronautical Systems Division, AF Systems Command, Wright Patterson AFB, Ohio

May 2-4—18th Annual National Forum American Helicopter Society, Sheraton Park Hotel Washington, D C

May 2-11—International Space Research and Technology Exhibition, London, England Sponsor British Interplanetary Society

May 3-4—First International Congress on Human Factors in Electronics IRE, Lafayette Hotel, Long Beach, Calif

May 7-9—Materials & Processing for Space Environments Symposium Society of Aerospace Material and Process Engineers, Hotel Statler, St Louis, Mo

May 7-11—Annual Conference Society of Photographic Scientists and Engineers Somerset Hotel, Boston, Mass Cosponsor AF Cambridge Research Laboratories

May 7-11—1962 Tool Exposition & Engineering Conference Public Auditorium, Cleveland, Ohio

May 8-10—12th Annual Electronics Components Conference, Marriott Twin Bridges Motor Hotel, Washington, D C

May 14-16—National Aerospace Electronics Conference, Institute of Radio Engineers Biltmore Hotel, Dayton, Ohio

May 14-16—Joint Technical Society Department of Defense Symposium on Thermionic Power Conversion, Antlers Hotel, Colorado Springs, Colo

June 19-22—Summer Meeting Institute of the Aerospace Sciences, Ambassador Hotel, Los Angeles Calif

Aug. 21-24—Western Electronics Show and Conference, Institute of Radio Engineers Los Angeles, Calif.

COOL HEADS for HOT SPOTS



(Or: The Stirring Saga of Sulfur Hexafluoride Subdued)

Over coffee one recent morning (our engineers always go right on thinking during coffee breaks), we observed one of the shining lights of our Environmental Control Systems Department wearing a grin that can be described only as Cheshirean. Ignoring previous experience under the stimulus of present curiosity, we inquired into the cause of his bliss.

Seems that the dielectric properties of air aren't good enough for it to be used as a pressurization gas for many of the high-power waveguide sections* being used today. The best job is done by SF_6—a gas that packs 2 to 3 times the dielectric strength of air at normal pressure, and even more at higher pressures.

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At this point, our ad manager thinks we should remind you that our Environmental Control Systems Department didn't get into SF_6 handling by accident. We've been designing and manufacturing heat exchanger systems, refrigeration and air conditioning systems and pressurizer/dehydrators for electronic equipment for over 20 years. If you've got an equipment or tube cooling problem . . . space, ground or sea . . . or an operating gas problem with waveguides, cavities, rotary joints, coaxial lines or similar components, it's a sure bet you should know more about our current activities. Write Environmental Control Systems, Budd Electronics, 43-22 Queens St., Long Island City 1, N Y.

*R&D terminology for glorified ducts.



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COVER: Orbiting Solar Observatory 1 (OSO-1) satellite designed by Ball Brothers Research Corp. was launched by National Aeronautics and Space Administration Mar. 7 from Atlantic Missile Range into a near-circular orbit by a Douglas Thor Delta vehicle (AW Mar. 12, p. 310). Satellite is designed to obtain measurements for a statistical analysis for predicting solar flares. It carries 13 scientific instruments. The 450 lb. satellite has a 96 min. period, apogee of 370 mi. and perigee of 340 mi.

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Thorns in the Rose Garden

The current controversy over the B-70 Mach 3 bomber program now raging between the Pentagon and Capitol Hill is one of the most curiously muddled dramas ever played in a city famous for this type of performance. We suspect that the furor raised by Rep. Carl Vinson (D-Ga.) over the current status of the B-70 program was aimed at little more than teaching Defense Secretary Robert S. McNamara some more realistic political manners. While President Kennedy's walk with Rep. Vinson in the White House rose garden may have achieved the goal of the Georgia 'swap fox," there are still some thorny aspects of this Congressional-Executive branch relationship on defense problems that are likely to draw blood in the future.

Much more fundamental to this conflict is the growing concern in Congress over the concentration of all this country's deterrent strength in the warheads of ballistic missiles. Never before in our history has this nation put all its military eggs in a single basket, as Defense Secretary McNamara now proposes to do with his concentration on Atlas, Titan, Minuteman, Polaris, Skybolt and possibly the mobile medium-range ballistic missile (MMRBM). Congress does not have the technical experience to argue against this policy in detail although it has visceral doubts as to its wisdom. There is also a growing feeling in Congress that Mr. McNamara's understanding of technology is more applicable to Edsels than to aircraft, missiles and space technology. His public statement attacking the B-70 program did little to dispel this feeling.

Classic Example

The B-70 program is another classic example of how executive indecision and budgetary fluctuations can vitiate any technological advance. Mr. McNamara deserves no special blame for the current plight of this program as these fluctuations began three years ago. He has added only the last few oscillations to this destructive cycle and he is merely perpetuating the well-proven fallacy of trying to develop a basic new weapon without all of the advanced subsystems necessary to its function as a complete combat system.

It is appalling at this time in our technical history to hear him argue against developing a new weapon system because it involves some unsolved technical problems. If this philosophy had prevailed in 1955 when the ICBM program was first organized with top priority—and it was voiced by a dour minority at the time—we certainly would never have tackled the job of developing Atlas, Titan, Minuteman and Polaris. Basic state-of-the-art advances of enormous magnitude were required then in all of the key areas vital to ICBM success—propulsion, guidance, re-entry vehicles and warheads.

A phrase in Mr. McNamara's B-70 polemic that is bound to catch the combat veteran's eye is his claim that the B-52 and B-58 could penetrate to enemy targets "as well or almost as well" as the B-70. We recommend that he turn for a moment from his accountant and scientist advisers to get a realistic description of what penetrating to an enemy target "almost as well" really involves.

Bomber Cut Questioned

Congress still doubts the wisdom of Mr. McNamara's decision to close down the B-58 and B-52 bomber production lines this year and questions the validity of his assurance that he could crank up the B-52 line again in only 18 months and at a cost of $300 million if he felt it necessary in the future.

Air Force leadership has helped to muddle this picture by some extremely sloppy presentations of its case for the RS-70 and a stubborn refusal to abandon its emotional attachment to this project in favor of some hard technical arguments to support its case for continued development of mixed deterrent forces. As for the B-70, it should either be pushed hard as a complete weapon system or mercifully killed. To pursue the present course of limited development and further study will only waste defense dollars and technical talent and produce no useful result.

Although President Kennedy's walk in the White House rose garden may have produced the immediate political compromise desired by Rep. Vinson, we predict that the size and character of the U.S. strategic deterrent forces will continue to be a thorny issue. The knowledgeable defense veterans on Capitol Hill do not appear ready to accept Mr. McNamara's sole reliance on ballistic missile warheads and will continue to press for development of as wide a variety of deterrent delivery systems as our technology will offer. —Robert Hotz



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WHO'S WHERE

In the Front Office

Richard L. Shetler general manager of General Electric Co.'s Defense Systems Department Syracuse, N.Y. elected a director of Apparatenindustrie Defense Electronics N.V. the Hague, Netherlands, a subsidiary of GE.

Harry L. Brown, vice president engineering Guidance Technology, Inc., Santa Monica Calif.

Robert H. Brown, executive vice president, Tenney Engineering Inc., Union N.J.

Robert L. Jannen, vice president-sales, Leach Corp. Compton, Calif.

Robert H. Borders, executive vice president and a director, Schaevitz Engineering, Pennsauken, N.J.

Raymond E. Frederick, vice president Trak Electronics Co., Inc., Wilton, Conn.

Herbert D. Bissell, vice president-corporate marketing Minneapolis-Honeywell Regulator Co. Minneapolis, Minn.

Charles C. Camillo, vice president-engineering ITXR Division of Amphenol Borg Electronics Corp., Danbury, Conn.

Dr. C. W. Walton, vice president-research and development Minnesota Mining & Manufacturing Co., St. Paul, Minn., and **J. W. Selden,** division vice president-new products commercial development.

Capt. R. R. Seymour, deputy vice president flight operations Eastern Air Lines.

Honors and Elections

Sir George Gardner, controller of aircraft for the Ministry of Aviation and **N. E. Rowe,** director of Hawker Siddeley Aviation elected to Honorary Fellowships in The Royal Aeronautical Society. **M. J. B. Stoker,** retired secretary of the Helicopter Assn. of Great Britain, awarded Honorary Companionship. Also honored by the Society. **The Gold Medal** to Sir Arnold Hall, chairman and managing director of Bristol Siddeley Engines. **The Silver Medal** to Dr. D. Kuchemann, head of the Royal Aircraft Establishment's Supersonics Division, and Prof. E. J. Richards. **The Bronze Medal** to Dr. A. J. Barrett, head of the Royal Aircraft Establishment's Technical Department. **The British Gold Medal for Aeronautics** to F. W. Page, chief executive Aircraft Division English Electric Aviation. **The British Silver Medal for Aeronautics** to F. N. Slingsby, managing director of Slingsby Sailplanes. **The Wakefield Gold Medal** to J. E. Clegg, Weapons Research Establishment (Salisbury, Australia) and T. G. Thorne, principal scientific officer of the Royal Radar Establishment. **The R. P. Alston Memorial Medal** to P. Howlett, flight test observer of the Air Registration Board. **The Alan Marsh Medal** to C. T. D. Hosegood, chief helicopter test pilot for the Bristol Division of Westland Aircraft.

Vice Adm. John T. Hayward, USN has received the sixth annual Capt. Robert Dexter Conrad Award. The citation read in part: "For outstanding accomplishments in the planning, administration and direction of major and diverse research and development programs and related activities of the Department of the Navy . . ."

INDUSTRY OBSERVER

► Development cost of the 120-in. solid-propellant rocket motor for the USAF/Martin Titan 3 launch vehicle may run $90 to $100 million through preliminary flight rating test (PFRT). Aerojet-General, Lockheed Propulsion, Thiokol and United Technology submitted proposals Mar. 12 to Air Force Systems Command's Space Systems Division. Questions following oral presentations to SSD probed management capabilities of the contenders.

► **Army and Navy are considering need for a relatively unsophisticated fixed-wing troop-support aircraft to be operated and maintained by local personnel in such countries as South Vietnam. It would probably be propeller-driven, and able to fly slowly enough to spot targets in jungles.**

► Project scientists are deeply worried about the ability of the Delta launch vehicle to place the 165-lb. weight of the UK-1 international satellite into a 600-200 mi. orbit. Size of the satellite forced a change last summer to Delta from the Scout, and now U.S. may substitute a Thor-Agena B vehicle to ensure successful orbit. Change at this late date would push the launch well past its present scheduled Apr. 10 date.

► **Radiation weapons program at Air Proving Ground Center, Eglin AFB, calls for high specific-energy storage devices capable of delivering millions of joules of electrical energy in a few microseconds. APGC is seeking companies with research and development capability in this field.**

► Blast shields and instrumentation for the atmospheric nuclear test program are being installed in three Martin RB-57 aircraft by Cook Electric Co. under an AFSC Aeronautical Systems Division contract. Aircraft will be used for radiation sampling in the nuclear cloud.

► **Bell Aerosystems Co. has won NASA competition for a generalized study of spacecraft attitude control systems (AW Mar. 5, p. 15). Contract value approximates $50,000.**

► Navy's North American A3J Vigilante bomber has shown that it can be operated successfully from aircraft carriers, but its tail-ejection bombing system has presented such problems that it is estimated another year will be required to make the system operational.

► **Grumman A2F Intruder attack aircraft will use the Martin Bullpup air-to-surface missile developed to operate with automatic radar techniques instead of the present radio-command, pilot-operated control system. Intruder's radar will illuminate the target and give course information to the missile through the computer, built by Republic Aviation Corp. and installed in the A2F.**

► Industry proposals for cost-plus-fixed-fee study contracts for unmanned space flight operations facilities system were requested recently by NASA's Jet Propulsion Laboratory. Industry was invited to bid on any or all of three parts of the program comprising system evaluation, communications and status display. Fourth part, covering conversion and buffering equipment for IBM 7090 computers went directly to International Business Machines Corp.

► Value of star tracker-inertial guidance systems for ballistic missiles is being debated by defense planners. Increased accuracy gained from using the combination system is offset by reduced nuclear warhead yield due to increased weight of the guidance package. Packages are so expensive that some observers believe it would be cheaper to assign two missiles with conventional systems per target instead of one with combination guidance.

► Tomahawk is the designation of a new heavy assault weapon being studied by Martin Marietta's Orlando Division to U.S. Army requirements.

► Electronic countermeasures effectiveness of late-model Boeing B-52 bombers is being measured in current program at Air Proving Ground Center, Eglin AFB. Program includes practice runs against U.S. target arrays to check ability of Sage system to see through ECM techniques.

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Washington Roundup

Joint Missile Office

Navy will participate with Air Force in managing the mobile medium-range ballistic missile development program (see p. 16) in a joint office that will be formed principally to assure that the missile will be compatible with requirements for launching from ships and barges.

First launching of a Nike Zeus anti-missile missile from Kwajalein Atoll against a target re-entry vehicle launched by an Atlas missile in California was scheduled for late last week, but was not expected to be announced under an information policy that calls for secrecy until the first phase of the tests is completed.

Central Aero Club of Russia has supplied a great amount of new information on the Vostok 2 spacecraft and its ground equipment as a result of assistance by U.S. members of the Federation Aeronautique Internationale that Soviet space record claims were not sufficiently substantiated. The material is being translated and will be made public within two weeks.

Disarmament Survey

Sen. Hubert Humphrey is still trying to get the Foreign Relations Committee to release a survey of probable effects of disarmament on the 100 top defense contractors. Some members of the committee feel that it might be used by Russia to further the Soviet argument that the U.S. has a vested interest in prolonging the cold war. The survey, begun late in 1960 and completed last fall, was submitted to the full committee in January.

New Cocoa Beach, Fla., motel in which the Mercury astronauts have invested part of the money paid to them by Life magazine for exclusive rights to their personal stories will have an auditorium with a news center on its upper floor. Among the organizations planning to rent office space there is Life magazine.

Astronaut Donald Slayton still may fly a space mission in Mercury-Atlas 8 or in a two-man Gemini capsule if results of tests of the Air Force major under stress are favorable (see p. 15). Manned Spacecraft Center still wants him to pilot a capsule.

Scott Carpenter was picked to replace Slayton as MA-7 pilot because he is considered most ready for flight at this time. The shot is now scheduled for May 8, and Astronaut Walter Schirra will be backup pilot.

Science Coordinator

White House is expected to send to Congress this week a reorganization plan that would provide better direction of government scientific research efforts. It will take effect in 60 days unless Congress objects. The plan would give the President's scientific adviser and his staff statutory status, and Dr. Jerome Wiesner would serve both in the statutory post and as a presidential adviser. The new arrangement would make Wiesner available to Congress for questioning on government research policies and programs. Wiesner also would oversee activities of the Federal Council for Science and Technology. Sen. Hubert Humphrey has been calling for a government science coordinator for some time. At special hearings last year, he decried duplication and lack of direction in federal scientific programs.

Next objective of Chairman George Miller of the House space committee is to get the U.S. to adopt the metric system of measurement. He plans to press for passage of a bill as soon as his committee completes work on the authorization of National Aeronautics and Space Administration's programs for Fiscal 1963.

First test of a Japanese-made missile will be made in May if preparations at the new Nijima missile site are completed in time. Japan also plans to create a space research agency within the office of the prime minister to coordinate cooperation with other countries, but Japan does not plan to launch satellites by itself.

New Cape Canaveral

Florida now has a town called Cape Canaveral. It extends from Port Canaveral, which is just south of the missile launching site, to Cocoa Beach. R. A. Jamieson, a Pan American World Airways range division executive is mayor, but at the moment the town has no post office of its own.

Cairo newspapers have reprinted reports from other countries that Russia is negotiating with the United Arab Republic to supply it with guided missiles, but UAR officials have refused to comment.

Dr. S. Fred Singer, on leave as a professor of physics from the University of Maryland to work at the Jet Propulsion Laboratory, will join the Weather Bureau on June 1 to direct its expanding meteorological satellite program.

Maj. Gen. Arno H. Luehman, Air Force chief of information, has been nominated for command of the Sixth Allied Tactical Air Force at Izmir, Turkey. If the nomination is approved by the North Atlantic Treaty Organization and Greece and Turkey, whose pilots make up the Sixth, he would take command in June.

Latest space age squelch came from a member of the House space committee's science panel after another member had finished a long discourse at the annual meeting here last week. "I've figured out that he spoke for two micro-centuries."

—Washington Staff

Mobile Mid-Range Missile Delayed Again

Political and technical inputs from NATO nations continue to confuse picture, fray Pentagon tempers.

By Larry Booda

Washington—Defense Department has told the Air Force to revise its specifications for the mobile medium-range ballistic missile (MMRBM) to make them more detailed and more responsive to operational requirements established by Defense Secretary Robert S. McNamara, including provision for sea-based launch. The action is expected to delay the release of requests for industry proposals by at least several months. It was accompanied by a bitter exchange between Defense and Air Force officials.

Since the decision was made last October to go ahead with development of the missile, international and military politics have so affected attempts to complete a set of specifications on which to base requests for proposals to industry that some Pentagon officers have dubbed it the "Mobile Political Missile."

John H. Rubel, assistant secretary of defense and deputy director of defense for research and engineering, who has been overseeing the project for the secretary of defense, has found himself caught between service ideas and the State Department, which represents the views of the North Atlantic Treaty Organization (NATO).

The MMRBM project received its first impetus early last year when Gen. Lauris Norstad, supreme allied commander in Europe and commander-in-chief of the U.S. European Command, stated that such a weapon was urgently needed for use by the NATO nations for gradual replacement of aircraft that are covering ranges from 200 to 2,200 mi. Secretary of State Dean Rusk strongly supported him.

Gen. Norstad is the theater commander Secretary of Defense Robert S. McNamara referred to in his document supporting his stand on the Air Force RS-70, who wanted a nuclear warhead missile to replace aircraft (see p. 17).

The original Air Force idea for such a missile was called Midgetman. This would have been a truck-mounted, two-stage missile. Specifications for it were applied to some extent to the MMRBM document. When it was first proposed only the truck-mounted approach was stated as a requirement.

As NATO nations were consulted, all but one asked that a sea-based version be included, so the missile could be deployed on barges and ships. Many wanted to eliminate land deployment altogether.

Rubel, who has made many trips to Europe to discuss the MMRBM with NATO officials, was forced to pass on these altered requirements to the Air Force. The specifications were rewritten but Rubel considered them insufficiently detailed to be the basis for requests for proposals. He ordered the Air Force to rework the specifications again.

Resentment Expressed

Resentment over what some officials called "overmanagement" by Rubel arose in the Air Force. Some technical requirements were also considered too demanding—for example, inclusion of a two-star tracking-inertial guidance system.

The showdown came three weeks ago when Rubel and Joseph S. Imbrie, assistant secretary of the Air Force for material, met on the subject of changing the specifications. Result was the Rubel order to rewrite.

Now the Air Force has assigned the commander of its Ballistic Systems Division, Maj. Gen. Thomas P. Gerrity, to deal directly with Rubel. The system program director for the MMRBM at BSD is Col. Edmund F. O'Connor.

In order to gain more information before writing the specifications, Gen. Gerrity has arranged for officials of the Aerospace Corp. and officers from BSD to go to Wiesbaden, Germany, where a Supreme Headquarters Allied Powers Europe group concerned with planning NATO defenses is located. The U.S. group will try to alleviate concern on the part of the Europeans and explain details of the command and control system.

Some of the deployment problems will be discussed. Political considerations will dictate the type of manning, for instance. Should the crews be multilateral? National? Under NATO control completely? Who will control the warheads? What criteria will guide deployment? Where? When?

Presidential Control

Not the least problem to be solved by the group and at higher levels is the degree of control the President of the U.S. will have over the system. If it becomes necessary to respond to an attack, some provision will have to be made to have the MMRBM responsive to the U.S. command and control system. This involves possible changes of laws by the U.S. and other NATO nations, particularly France.

Introduction of the sea-basing requirement adds technical complications to an already highly sophisticated system housed in a small package.

Land-based systems can use relatively simple pendulum devices to establish vertical alignment of the missile guidance system prior to launch, whereas sea-based launch requires more complex vertical-sensing devices to compensate for ship rolling and pitching motions.

MMRBM will be a small missile, weighing only 11,000 lb. gross and measuring 23 ft. in length. It will be a two-stage solid-propellant vehicle. The missile airheads has been assigned a package that will use a combination of a two-star tracker and an inertial guidance system. Single-star trackers have been developed and two-star trackers are being developed for larger missiles. Polaris, a larger missile weighing 35,000 lb., uses only inertial guidance.

Reason given for wanting a two-star tracker-inertial package would be to radically improve the missile's circular error probability. This improvement would be gained at the cost of a smaller warhead, since it would add weight.

Maintenance of these missiles by European personnel in operational use has raised the question of whether such a complex weapon system moving around the roads of Europe can be kept in a satisfactory state of readiness.

Another technical problem deals with the sensitivity of ballistic missile sound vibration damage, produced by their own engines. This varies with environment, which will vary as the missiles are moved about.

The task the Air Force is now embarked on is an effort to obtain all of the political and technical information it can to include in the new specifications, which will be used as a guide by the writers of industry proposals.

These specifications will reflect a growing trend by DDRE to guide design proposals into narrower channels, consequently allowing the contractors less leeway.

Dyna-Soar Costs

USAF Boeing Dyna-Soar contractors were told to pare $21 million from procurement costs in the space glider program during the next three years to match budget limitations set by the government.

Eight major subcontractors and about 20 other suppliers at a one-day symposium in Seattle heard officials of Boeing Co., Dyna-Soar system contractor, announce that the major subcontractors will have to cut nearly 50% from their estimated expenditures on the program in Fiscal 1963. The Boeing officials said they will save a proportional amount on their in-house work.

S-52 Satellite

Washington—Westinghouse Electric Corp. will build the S-52 satellite, the second of three satellites in a joint United Kingdom-U.S. international program under a $1-million contract being negotiated with the National Aeronautics and Space Administration. This is the company's first contract for a spacecraft. It will build two engineering test and prototype models and two flight models.

McNamara Views RS-70 as Doubtful Asset

Washington—Defense Secretary Robert S. McNamara's presentation against Air Force's reconnaissance-strike bomber program—widely circulated on Capitol Hill last week—argued that, even if successfully developed, the RS-70 would add little to the effectiveness of either the strategic striking or reconnaissance forces.

He criticized Air Force's former support for production of the XB-70 supersonic bomber, stating that even USAF itself now "implicitly" rejects this program by re-orienting it into the RS-70 program.

In summarizing the requirement for an RS-70 force, McNamara observed: "We calculate that the strategic retaliatory forces programed through 1967 could achieve practically complete destruction of the enemy target system—even after absorbing an initial nuclear attack. The addition of a force of either 200 B-70s, which was proposed last year by the Air Force or the 150 RS-70s now being considered, either of which would cost about $10 billion, would not appreciably change this result.

"With regard to the wartime reconnaissance capabilities of the RS-70, we have other means of performing that function and with any adequate high-processing-rate radar system which may be developed, the B-52s and B-58s could have a considerable reconnaissance and bomb damage assessment capability incident to their principal mission. We think that the B-52s and B-58s, arriving after our missiles have suppressed the enemy's air defense, could penetrate as well or almost as well as the RS-70.

"A decision by the Soviet Union to produce and deploy an anti-ICBM system could not significantly change this over-all picture and in any event would be no less effective against the RS-70 and its missiles. To ensure that our missiles can reach their targets even then, we have included a substantial sum in the 1963 budget for a 'penetration aid program.' We also have the option of increasing the Minuteman program for which extra production capacity has already been provided."

McNamara said: "Interestingly enough, at the very time the Air Force is urging the production of another aircraft system on the grounds that nuclear armed missiles are not dependable, (see p. 16) one theater commander is requesting the production of a new nuclear-armed missile to replace his aircraft which he says are too vulnerable in a nuclear war environment. And while the Air Force, in pressing its case for a new bomber, has questioned the dependability of nuclear-armed missiles, it is at the same time urging an aircraft—the RS-70—which itself depends for its strike capability on highly sophisticated nuclear-armed missiles.

Because of the highly advanced technology which will be involved in developing the key radar communication and missile subsystems for the RS-70, McNamara maintained that a year's delay in deciding whether to proceed with RS-70 aircraft construction would not postpone the real operational readiness of the first wing at all.

Detailing the problems involved in the three subsystems which will determine the effectiveness of the RS-70, McNamara said:

- **High resolution radar.** "Picture the RS-70 flying at 70,000 ft. and moving at 2,000 mph. The proposed mission would require the gathering of radar reconnaissance data on the presence of new targets—or known targets which may not have been destroyed or neutralized—and the prompt processing and analysis of these data in flight. The proposed radar, moving with the aircraft, would be seeing new area at the rate of 100,000 square miles per hour or 750 million square feet per second. We cannot state today with any assurance that satisfactory equipment to perform this processing and display function in an RS-70 can be made operational by 1970 . . . or whether the human interpretation job required of the operator can ever be done."
- **Communication.** "The RS-70 . . . is also to have the capability of transmitting to home base processed radar data on important target areas. . . . However, the assumed rate of transmission over intercontinental ranges in a wartime environment would be only a minute fraction of the rate at which the data are being required and processed by the RS-70 radar."
- **Missile system.** "The RS-70 would also require the development of new air-launched strike missiles. For use against hard targets these missiles, because of their limited size and warhead yields, would have to be far more accurate than any strategic air-launched missile now in production or development."

Restudy of RS-70 Is Ordered; Vinson-McNamara Clash Averted

By Katherine Johnsen

Washington—Thorough restudy of Air Force's reconnaissance-strike bomber program was ordered last week by Defense Secretary Robert S. McNamara as part of the strategy directed by President Kennedy that incited a bitter clash over the program between Congress and the Administration and between two powerful committees of the House.

McNamara's action was announced by Rep. Carl Vinson (D-Ga.), chairman of the House Armed Services Committee, at a committee session called only a few hours before the start of House floor debate on the Fiscal 1963 authorization for aircraft and missile procurement. The committee promptly and unanimously voted an amendment which removed from legislation a provision that "directed" the Air Force to use $491 million for acceleration of the RS-70 program—over McNamara's opposition (AW Mar. 12, p. 30).

The restudy decision followed by a week McNamara's release of his detailed statement of opposition to an expanded RS-70 effort which would involve development of six aircraft (see box). Defense Department's program earmarks $171 million of funds already voted by Congress to develop three aircraft.

The measure, authorizing over $4 billion for missiles and over $6 billion for aircraft, including the $491 million for the RS-70, was unanimously approved by the House, 403 to 0.

House appropriations committee members had been prepared to fight the

provision directing Air Force to spend money on the grounds that it invaded their prerogative to appropriate funds and decide what programs authorized by the Armed Services Committee should be implemented (AW Mar 19, p 28).

In his letter to Vinson, McNamara said that "we are initiating immediately a new study of the RS-70 program in the light of the recommendations and the representation of the Armed Services Committee. This study will give full consideration to the magnitude of the committee program and the depth with which the committee has emphasized this. Furthermore, if technological developments advance more rapidly than we anticipated, we will wish to take advantage of these advances by increasing our development expenditures, and we would then wish to expend whatever proportions of any increase voted by the Congress those advances in radar technology would warrant."

A letter from the President accompanying McNamara's letter to Vinson said that it is "incumbent upon the Executive to give every possible consideration to the views of the Congress. For that reason, Secretary McNamara has indicated to you his willingness to reexamine the RS-70 program and related technological possibilities."

The peaceful settlement of the RS-70 controversy was variously interpreted by members of Congress—from a complete victory for Vinson's Armed Services Committee to a complete victory for McNamara, who would now, as one representative said, go through the motions of making a study and then use it as justification to brush the whole B-70 matter under the rug and be rid of it.

Vinson viewed the outcome as a realistic and wholly natural conclusion of the whole matter." He said he believed McNamara "was worried about flying directly in the face of the Congress, because this was a war he could never win, even if he did win a battle now and again. His second worry was that maybe he was wrong about the RS-70. He could do only one thing—seek some compromise which would allay both of these fears. He arrived at the right answer—and I am very glad that he did. Reason and common sense have won out."

Vinson assured the House members on the floor speech that "we are going to watch this new study by the department every step of the way from this point on.

"We are going to make sure that every advance developed by the study will be translated—and immediately translated—into the expenditure of funds for the most rapid possible advancement of the RS-70," he said.

Slayton Controversy Emphasizes Widening Breach Within NASA

By Edward H. Kolcum

Washington—Medical disqualification of Maj. Donald Slayton seven weeks before his scheduled flight the next Mercury mission underscores a widening breach between Washington space officials and those in the field which becomes more pronounced with the expansion of the National Aeronautics and Space Administration.

Sudden removal of Maj. Slayton came Mar. 15 after a panel of Air Force and civilian cardiologists recommended his disqualification because of a heart flutter. This recommendation provided over the opinions of the astronauts' personal physician, other aeromedical specialists and Project Mercury officials.

The Slayton case is one of several actions taken in Washington which have caused resentment in the field during the past 12 months. About a month before the Mercury Redstone-3 flight of Cdr. Alan B. Shepard, Jr., a panel convened by Dr. James Hartgering, special assistant to Dr. Jerome B. Wiesner, White House science adviser at Wiesner's request, recommended the flight be postponed until additional physiological data could be obtained on man's responses to space flight (AW Aug. 21, p. 26).

They felt specifically that too little was known about the metabolic process undergoing because of extremely high pulse and respiration readings recorded in both X-15 and Mercury centrifuge missions. These high readings are considered normal by aeromedical specialists.

Mercury program officials and military aerospace medicine specialists convinced the panel, after hurried Redstone profile runs on the Navy's Johnsville centrifuge, that pilot safety was assured.

A second source of resentment was appointment of a foreman consultant for manned space flight Jerrie Cobb by James E. Webb, NASA administrator. The appointment was made without first discussing it with program officials who saw it as a publicity stunt at their expense. Webb's close ties in Oklahoma, Miss Cobb's home state, did not help the matter.

The Slayton incident is the most serious rift since it involves questions of professional judgment, responsibility and authority. Although there undoubtedly have been other times when headquarters has overruled the field, there has never been a more embarrassing situation because the spotlight is continually on the astronauts.

Maj. Slayton's heart condition had been known and well-monitored since August, 1959. His selection as Mercury Atlas-7 pilot was made by the Manned Spacecraft Center last November after an Air Force board, two independent cardiologists, his physician and several members of NASA's Life Sciences Committee determined that the flutter was minor and not prejudicial to his health or ability to fly the mission.

This selection was overruled by Webb on the advice of Air Force Secretary Eugene M. Zuckert after the Air Force panel had met with Maj. Slayton in a consultation. The panel consisted of three civilian cardiologists and eight Air Force aeromedicine specialists. Air Force said the group concurred in the recommendation that Maj. Slayton not fly a Mercury mission at this time, but some Air Force members dissented.

USAF members were Brig. Gen. Charles H. Roadman, director of NASA aerospace medicine; Lt. Col. Stanley White, director of life sciences at NASA's Manned Spacecraft Center; Lt. Col. William K. Douglas, the astronauts' personal physician, and these members from the Surgeon General's Office: Maj. Gen. Ambrey Jennings, Brig. Gen. Don Wenger, Col. Karl Houghton, Lt. Col. Charles Berry and Lt. Col. Wilbert McElroy.

Civilian members were Dr. Proctor Harvey, professor of cardiology at Georgetown University; Dr. Thomas Mattingly, heart specialist at Washington Hospital Center, and Dr. Eugene Braunwald, cardiology researcher at the National Institute of Health.

Indications are that civilians on the panel were unanimous in their recommendation to ground Maj. Slayton, but Air Force members were divided. The united front presented by the USAF panel to ground the astronaut in MA-7 is believed to have stemmed from these considerations:

- **Any malfunction** during the mission—even if the vehicle blew up on the pad—would be blamed on Slayton's heart with the opening for a charge that a bureaucratic government group overruled eminent civilians.
- **Scientifically**, if Maj. Slayton's defect occurred while he was in flight, normal electrocardiographic readings would not be returned and the prime mission of Mercury is to obtain baseline data for more advanced manned space flight.
- **Not enough is known** at this time about the condition under stress.

Those who oppose the decision do so on the grounds that those who are best qualified to make a medical assessment were overruled and second guessed in a very important decision.

The White House had nothing to do with the Slayton decision. Dr. Hartgering said the first he knew of it was from the newspapers. A White House official said President Kennedy did not enter into the decision. "The President," he said, "has consistently held NASA responsible" for the space program.

Gen. Roadman, who became chief of NASA's aerospace medicine program last November, apparently triggered the reassessment of Maj. Slayton. Gen. Roadman went on duty with NASA in mid-1960 from the USAF Directorate of Research and Advanced Technology, in a joint USAF-NASA attempt to quell the battle between NASA and USAF on division of bioastronautics responsibilities, which was then at its peak.

He did not have direct dealings with the manned space flight program until last November, however, since the Mercury bioastronautics were handled directly by the office of space flight programs, rather than the old life sciences office until then.

Gen. Roadman learned of Maj. Slayton's condition diagnosed as idiopathic paroxysmal atrial fibrillation, about a month ago. After the two senior Defense Department cardiologists recommended that Slayton not fly, Gen. Roadman discussed the case with Project Mercury officials and then he asked the USAF Surgeon General, Maj. O. K. Ness, to convene a panel early this month on Maj. Slayton, since he is an Air Force officer.

Aeromedical specialists regard as curious the decision to call in civilian consultants, no matter how eminent, who have no backgrounds in stress evaluation. Clinical studies are normally made of sick persons while aeromedical work involves those who are healthy. One aeromedical specialist said he doesn't understand why this specialty was not considered the final authority when so many of us have been working together on this for so long."

Another said it could be a question of "too many doctors," when only one has the specific knowledge, judgment and experience required to make a decision on Slayton. The one with this knowledge was identified as Col. Douglas, the astronauts' personal physician who discovered and diagnosed Maj. Slayton's heart flutter when electrocardiogram leads were being attached for his first Mercury centrifuge run at Johnsville, Pa.

Dr. Douglas immediately called in a cardiologist in Philadelphia, who, after an exhaustive consultation, said he found no reason why Maj. Slayton should not stay in the program. In November 1959, Dr. Douglas took the astronaut to the School of Aviation Medicine at Brooks AFB, Tex., where a board headed by Dr. Lawrence Lamb found his condition was not disabling and recommended his continued participation in Project Mercury.

To verify these findings Dr. Douglas subsequently asked Brig. Gen. Don Flickinger, now an independent Washington consultant to arrange a consultation with an eminent New York cardiologist. The cardiologist found no reason to disqualify the astronaut. At the time of this consultation, Gen. Flickinger was special assistant for bioastronautics in the USAF Systems Command and a member of NASA's Life Sciences Committee.

Dr. Douglas will be transferred after the MA-7 flight to Patrick AFB, where he will be deputy assistant for bioastronautics. His transfer did not result from his disagreement with the Slayton decision, according to his immediate superior, Dr. White. Dr. Douglas' transfer had been planned several months before the incident, Dr. White said.

Dr. Hugh L. Dryden, deputy NASA administrator, Robert R. Gilruth, director of the Manned Spacecraft Center, and Lt. Cdr. Scott Carpenter, new pilot-designate for MA-7, are others who have voiced exception to the decision.

Procurement Revisions

Washington—Defense Department last week placed in effect a new Armed Service Procurement Regulation (ASPR) revision designed to reward defense contractors with up to 15% gross profit for excellence of contract performance or punish them by reducing profits or assessing penalty charges for poor performance (AW Feb. 26, p. 25).

Deputy Defense Secretary Roswell Gilpatric explained that the new incentive system allows credit points in three categories for reduction in costs below those estimated at the beginning of a contract, better performance than expected throughout the life of the contract and product reliability greater than originally stated in contract specifications.

Atlas Malfunction Probed

USAF safety team last week continued its investigation of a malfunction and fire Mar. 13 at an Atlas ICBM site 15 mi. southeast of Topeka, Kan., which caused buckling and partial collapse of the missile's thin skin.

The General Dynamics Atlas E, sheltered in a concrete "coffin launcher" flush with ground level, apparently buckled when failure of an electrical or mechanical system resulted in loss of internal pressurization.

Avionics Integration

Washington—Navy's Bureau of Weapons will award one or more study development contracts for integration of all avionics equipment aboard an attack aircraft, with emphasis on the use of microelectronics and solid state circuitry, for use on the proposed VAX lightweight attack aircraft.

Bureau of Weapons, which pioneered the integration of communication navigation identification equipment into a single package, will expand this to include weapons delivery, radar, instrumentation, displays and automatic controls.

During a Washington press conference after the announcement that Slayton was disqualified, Dr. Dryden commented, "Let's make it clear. Deke [Slayton] is ready to go as far as I'm concerned."

Gilruth said, "... my own feeling is that Deke is an extremely competent engineer-test pilot and entirely capable of the mission. In no case has the abnormality interfered with Deke's performance."

Carpenter said he doesn't "like to be part of something of such great disappointment to Deke."

Slayton's Future

Maj. Slayton, who will return to the preflight spacecraft checkout billet he held for the MA-6 flight of Marine Lt. Col. John H. Glenn, probably will be assigned to Mercury Control as capsule communicator for the Carpenter flight.

He heard Mar. 13 that his selection was to be re-evaluated and he was called to Washington the next day for the consultation. At news conferences in Washington and Langley Field, his feelings were obvious. He said he is "damned disappointed," and he was "shot out of the saddle unexpectedly."

Maj. Slayton said the condition is a minor defect—"like having one brown and one blue eye." He said it doesn't affect his performance and it is not brought on by stress.

The worst result of the defect could be a reduced efficiency in the pumping action of the heart, but Dr. Douglas said Slayton is "abundantly capable of the mission."

Idiopathic means cause unknown, paroxysmal means sporadic; atrial refers to the filling receptacle for blood entering and leaving the heart, and fibrillation increased and rhythmic beat.

Dr. Randolph Lovelace II, whose Albuquerque, N. M., clinic assisted in the medical evaluation of the astronaut candidates in early 1959, said Slayton "showed no sign of difficulty at the time of his selection. He came through with flying colors."

Reusable, Orbiting Space Carrier Studied

By Irving Stone

Los Angeles—Reusable, 10 ton, earth to-orbit carrier vehicle to start operation at the beginning of the next decade for large scale transportation of personnel and cargo in support of manned space stations, lunar bases and early manned planetary expeditions, will be explored in a six-month study program to be sponsored by NASA's Marshall Space Flight Center.

Industry proposals for the study now being evaluated were submitted Mar. 21 in response to MSFC's RFQ No. TP 2-74 007 which anticipates a cost plus fixed fee contract, expected to cover about 7,000 engineering man-hours.

Economic Philosophy

Study is prompted by the economic philosophy that the projected state-of-the-art for medium sized, orbital carriers will offer transportation for 10-to-15 ton payloads to low-altitude earth orbits with boost vehicles such as Saturn C-1 or Titan 3—both expendable launchers designed as an extension of existing ballistic missiles. It is estimated that direct operating cost per launch will be $10 to $15 million with a mission reliability of 80% to 90%. Specific transportation cost (direct operating cost only) is estimated to be $100 to $400 per pound of payload between 1966-1969. Poor economy and mission reliability of this operational mode won't satisfy mission requirements and firing rates anticipated for the 1970 decade, hence a more efficient earth-to-orbit transportation scheme will be required.

Vehicle concepts to be considered under the study will involve configurations having a minimum capability for accommodating a two-man crew and 10 passengers to a rendezvous-compatible orbit for approximately 175 naut. mi. altitude and return to launch site. An alternate mode of operation anticipates a 10-ton possibly greater, cargo capability to the same orbit. Primary emphasis will be placed on operational considerations such as crew and passenger safety, a high usability rate and a launch area not necessarily limited to the Atlantic Missile Range.

Basic concept underlying these approaches "should be compatible with a philosophy used in the development of supersonic commercial jet aircraft and should offer a potential commercial application in the late 1970s, such as operating the vehicle over global distances for surface-to-surface transport of cargo and personnel," MSFC specifies. But economic efficiency will be secondary compared with safety considerations.

Detailed guidelines governing the study include the following:

- **Operational and economic studies** will be based on launch rates of 4, 8, and 16 per month and an operational time period of 10 years will be used to calculate total operating costs. Launch rates for the development phase will depend on the contractor's projection of buildup schedules.
- **Limit of accelerations** to which passengers will be subjected is specified as 2g during ascent and descent trajectories in the standard mission profiles. An emergency situation would permit a limit of 4g.
- **Cargo vehicle** could have a crew or be fitted with an automatic guidance, control and rendezvous system. The automatically controlled empty vehicle would be left in orbit or returned to the launch site. The mode of operation would be based largely on the assumption of fairly high traffic densities.
- **Design goal** and ultimate operational requirement will aim at a mission reliability of at least 99%. Development goal will require a mission reliability of not less than 95% before the vehicle flies initially.
- **Propulsion systems** need not be based on engines now under development but when these developments are operationally acceptable they are to be considered.
- **Abort requirements** will influence propulsion system selection and shaping of the trajectory, hence, abort will have to be studied in detail.
- **Calculation of standard** performance data will be based on launch over the Atlantic Missile Range and due east azimuth but influence on payloads of other launch locations and azimuth angles will have to be considered.

The carrier vehicle eventually will be incorporated into Orbital Launch Operations—OLO—(AW Mar. 19, p. 78), but present plans do not include it because it is still in the conceptual stage of development.

Comprehensive lists of design and analysis criteria will be developed by MSFC for adoption by participants in the study so that various vehicle designs will be comparable directly.

Vehicle Concepts

Typical vehicle concepts to be investigated in the study include:

- **Vertical ascent rocket plane.** This vehicle would use launch facilities and operations similar to those for the Saturn C-1. It will be a two-stage configuration, will use a winged booster powered by liquid-propellant multiple engines for acceleration to Mach 5 to 7 before stage separation, when the booster will re-enter for subsonic flight to a landing site under turbojet power.

Second stage would use high-energy chemical propellants, also would be a winged configuration to return as a glider to the launch site after one or more revolutions around the earth.

Payload-carrying vehicle would have a propulsion system for final approach and rendezvous in orbit and for the retardation maneuver out of orbit. This vehicle is seen as a fixed-wing glider which may have additional semi-rigid flexwings for letdown.

- **Horizontal takeoff rocket plane.** This configuration would be supported on the ground by wheels or a sled on guide-rails and be boosted by takeoff-assist devices to a liftoff velocity compatible with wing size and the design of the undercarriage. After liftoff the vehicle enters a steep ascent.

Power may be supplied by a single rocket or a two-stage combination. A single-stage rocket probably would have to use a high energy propellant and high chamber pressure to develop sufficient thrust to put the vehicle into orbit, where the payload would be separated and the vehicle returned to the landing site. A variation of this technique could have the payload portion contain a propulsion system with enough thrust to perform the rendezvous and a retardation maneuver, so that the basic vehicle could return to earth after one orbit around the globe.

Two-Stage Configuration

If the vehicle were a two-stage configuration, the first stage could return after attaining a speed of Mach 5 to 7 and separation from the second stage. The second stage could use one or more high-energy propellant engines to attain the programed orbit then rendezvous, unload passengers or payload, and return to the launch site.

In each case, the individual stages and payload might have flexwings for lift augmentation during landing.

- **Horizontal takeoff air-breathing plane.** A vehicle utilizing a propulsion scheme based on the Aerospace Plane concept could be considered as an alternate approach, probably would have the most feasibility for providing an orbital carrier with global surface to surface transportation capability. However, since the Aerospace Plane concept has been studied in detail by Air Force contractors, it will not be included in the study program for primary analysis, although results of these Air Force studies might be used for comparison.
- **Nuclear rocket.** A reusable single stage nuclear rocket could be analyzed as a competitive system but a detailed operational study emphasizing radiation problems would have to be included. Example of this category is Douglas Aircraft Co.'s concept of the reusable interplanetary transport approach (Rita).

Rita Vehicle

The Rita vehicle (AW Mar. 20, 1961, p. 50) would be a cone-shaped configuration involving a single stage self-contained propulsion system with out-expendable parts so that it could be flown, landed, and re-flown like an aircraft.

The study report will be required to present a minimum of two vehicle concepts, will have to include weight and performance data for each design, cost effectiveness of each system, preliminary development plan and schedule of selected systems, an analysis of how the design goal of 99%, and the initial operational reliability at 95%, would be achieved, and pinpoint problem areas considered critical or beyond the present state-of-the-art.

Aerospace Surveillance Proposals Studied

Air Force's impending aerospace surveillance system study, for which industry proposals (AW Feb. 19, p. 23) are now being evaluated, may be the first major investigation under the new planning study concept.

One, possibly two, studies will be awarded soon by USAF's Electronic Systems Division for studies of future space surveillance and missile warning systems under a planning study designated 7990-21.

Initially, the study was intended to combine into a single effort two projected Air Force study requirements, SR 17545 and SR 17546. The first of these, SR 17545, was entitled "Passive Optical Surveillance System," while the second, SR 17546, was "Surveillance and Warning Environment." The two SRs would, in effect, be Parts A and B of the planning study.

Part B will seek to develop concepts for, and a preferred configuration of, an integrated surveillance and tactical warning complex, relying heavily on radio frequency or radar sensors.

Part A, it now appears, will be de-emphasized. It was to have been concerned primarily with the feasibility of a concept for a space-based surveillance system using passive optics—infrared, visual light and ultraviolet.

NATO Nations to Produce Bullpup

Paris—Four NATO nations will participate in a NATO-sponsored European production program of the Martin Bullpup air-to-ground missile.

Nations involved are United Kingdom, Denmark, Norway and Turkey. U.S. involvement is mainly one of technical aid although U.S. reportedly may also procure certain quantities of the European built Bullpup.

Meeting of the four nations will be held at NATO headquarters on Mar. 26. NATO sources hope final details, including selection of prime contractor and appointment of key personnel, will be settled at this meeting.

NATO backing of the Martin missile marks the third important missile program the organization has sponsored. Five NATO nations are swinging into production on a $500 million Army Raytheon Hawk air defense missile program. Nine NATO nations already are producing Sidewinder air-to-air missiles in a $40 million program.

Reportedly, dollar value of the four-nation Bullpup program will be similar to that of the Sidewinder. This figure, however, could grow as other NATO nations, notably West Germany, join the Bullpup program.

NATO sources declined to interpret their sponsorship of Bullpup program as meaning NATO has selected the Martin missile over Nord Aviation's AS-30. It was pointed out that the British have ordered both missiles. Moreover, NATO officials expect Nord will sell the AS-30 to other NATO members despite the Bullpup program.

NATO sources also revealed the organization has an expert group working on an advanced version of an air-to-surface missile. This effort in which most NATO members are participating, marks an attempt to establish a NATO designed weapons system—much as NATO did with the ASW Atlantic project and as it currently is doing with V/STOL fighter and transport projects.

McCloy Will Head World Peace Group

Washington—John J. McCloy, director of the Chase Manhattan Bank and former presidential disarmament adviser, last week was designated chairman of the 15-member general advisory committee to advise the President, Secretary of State and the director of the Arms Control and Disarmament Agency on world peace problems.

Other members of the committee confirmed by the Senate include the following:

Gen. Thomas D. White, former Air Force chief of staff and now vice president of Eastern Air Lines; Herbert F. York, former director of defense research and engineering, Defense Department and now chancellor of the University of California; Robert A. Lovett, former secretary of defense and now chairman of the executive committee of Union Pacific Railroad; George B. Kistiakowsky, professor of chemistry at Harvard University and a member of the President's Scientific Advisory Committee; Trevor Gardner, former assistant secretary of the Air Force and now president of Hycon Manufacturing Co.; Roger M. Blough, president, U.S. Steel Corp.; Rev. Edward A. Conway, associate professor of political science at Creighton University.

Also John Cowles, president of the Minneapolis Star and Tribune Co.; Dean A. McGee, president of Kerr-McGee Oil Industries; Ralph McGill, editor of the Atlanta Constitution; George Meany, president of AFL-CIO; James Perkins, vice president of the Carnegie Corp.; Herman Phleger, member of the San Francisco law firm of Brobeck, Phleger, and Harrison; Isidor Rabi, professor of physics at Columbia University, New York.

IAS/ARS Targeting February, 1963 Merger

Los Angeles—Target date for the proposed merger of the Institute of the Aerospace Sciences and the American Rocket Society is February 1963, providing memberships of both groups respond to a formal poll as they have indicated informally.

Presidents of both organizations, L. Eugene Root, Lockheed Missiles and Space Co., president of the IAS and Dr. William E. Pickering, National Aeronautics and Space Administration's Jet Propulsion Laboratory, president of ARS reported at an IAS meeting here that work is under way by a consolidated steering committee and five working groups appointed to study the pros and cons of the merger. A sixth group is considering long-range plans. Function of the working groups should be completed by early May after which a questionnaire will be submitted to the memberships of both groups. It is expected that major details of the merger will be solved by that time.

Name of the merged organization may be the American Institute of Aeronautics and Astronautics (AIAA), Root said, although no definite decision has been set.

Upcoming Atlas-Centaur Flight To Provide First Hydrogen Test

By George C. Wilson

Washington—Pace of the U. S space program depends heavily on the upcoming flight test of the Atlas-Centaur—the vehicle slated to perform the next deep space missions and to supply the first information on the use of liquid hydrogen for propulsion.

Atlas-Centaur, scheduled to be launched within the next few days, is being relied upon to fill the performance gap between the Atlas Agena and the Saturn class of space vehicles. Since Centaur will be the only booster available for deep space missions between now and when the Saturn is ready in 1963, its flight tests are especially critical to the National Aeronautics and Space Administration program (AW Oct. 2, 1961, p. 26).

The first Centaur flight test is scheduled to last about 15 min., with about 5 min. of that time under zero-g conditions. Centaur's two Pratt & Whitney, 15,000-lb. thrust A-1 engines will be started and run for a few seconds at zero-g as the vehicle heads downward after reaching the 276 naut. mi. apex of its planned trajectory (see chart).

Instrument Package

During the initial flight Centaur will carry more instruments than any vehicle so far launched in the space program. Instrumentation will range from a television camera peering into the liquid hydrogen tanks to a series of gages to record information about Centaur's structure, powerplant and guidance system.

USAF Col. Donald H. Heaton, director of vehicles in NASA's office of space science, told a House Science and Astronautics Subcommittee last week that the Centaur flight test will be especially valuable because of the knowledge gained about liquid hydrogen—the high energy fuel for the upper stages of the Saturn and Nova space vehicles.

One specific problem experienced in the Centaur program during ground tests is the excessive transfer of heat from the oxygen to the liquid hydrogen tank. Col. Heaton said NASA now feels this has been solved. Proof will come during the flight test.

Other Flights

The first flight is to be followed by nine others, ending in early 1964 when Centaur is to become operational under NASA's latest schedule. The initial flight test was scheduled originally for early 1961, but development problems with both the engine and the vehicle have delayed the program about one year.

Col. Heaton told the House subcommittee that "the engine problems of last year plus the myriad difficulties of mating the new engines, new propellant supply system, new guidance and control system and new static test and launch facilities into a functioning vehicle system" have been responsible for the delays.

He refused despite persistent questioning by subcommittee members to place the blame primarily on the Pratt & Whitney engine. "The engine problem was the ignition problem," he said. "I think its importance was unfortunately judged more by the spectacular results of the three explosions than by the difficulty in solving" the ignition problem. Col. Heaton said the ignition problem was solved rapidly and the engines are now progressing on schedule.

Since the engine explosions, Col. Heaton said, there have been over 700 successful engine ground test runs lasting as long as 80 sec. Later tests call for burning both engines for 270 sec., the maximum time they will run in flight.

Advent Satellite

He said the slippage in the Centaur development program has delayed the launching of the Advent military communication satellite and Surveyor unmanned lunar vehicle about six months.

NASA and the Air Force Systems Command are studying the possibility of injecting Advent into its proper orbit by using the Surveyor framework. Col. Heaton said Dick Clark, trajectory specialist at the Jet Propulsion Laboratory, proposed putting the Surveyor framework between the top of Centaur and Advent. At the prescribed 22,300 mi. height, a ground signal would command Surveyor to put Advent into position. Col. Heaton said Surveyor's engines appear to have just about the right amount of power to turn Advent into the proper plane and give it the necessary velocity to stay in orbit. The Surveyor framework would remain in orbit after completing its task. The weight of the Advent satellite is not a problem, Col. Heaton said. Advent's weight has not grown appreciably since the Centaur mission was planned, he said.

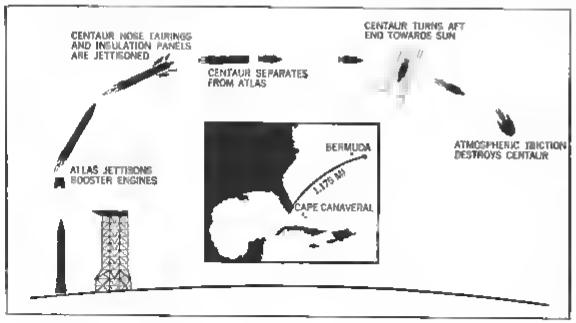
Other Roles

Other jobs for the Atlas-Centaur include carrying the Surveyor vehicle to the moon, the Mariner B vehicle to Mars and taking Advanced Research Projects Agency-NASA energetic particles satellites into space. Col. Heaton estimated that once Centaur becomes operational NASA missions alone will require launching 12 vehicles every year through this decade.

Total cost for making Centaur operational, Col. Heaton said, will be about $350 million. This compares with an estimate of under $200 million given by NASA Deputy Administrator Hugh Dryden last year (AW Oct. 23, 1961, p. 22).

The civilian space agency is asking Congress for $66.7 million for Centaur for Fiscal 1963.

To meet design payloads, NASA started in Fiscal 1962 and will continue in Fiscal 1963 an effort to reduce the weight of the Centaur vehicle. Steps include removing some of the telemetry, relocating tracking equipment from the second to the first stage and redesigning some of the electrical components. NASA is studying such other changes as repackaging the guidance components, redesigning the tanks and using different materials.



FLIGHT PROFILE for first Atlas Centaur test mission shows launch, staging and re-entry.

U.S., USSR Space Exploration Talks Near

United Nations, N. Y.—United States and Soviet representatives will begin private meetings here this week to investigate the possibilities of cooperative U.S.-USSR space explorations, as suggested by both President John F. Kennedy and Premier Nikita Khrushchev in a recent exchange of letters.

Francis T. P. Plimpton, U.S. deputy permanent representative to the United Nations and chief U.S. representative to the UN's Committee on the Peaceful Uses of Outer Space, will meet with Platon D. Morozov, his Soviet counterpart at the UN, to make arrangements for the discussions. President Kennedy named Dr. Hugh Dryden, deputy administrator of the National Aeronautics and Space Administration, to represent the U.S. in technical conferences with Prof. Anatoli A. Blagonravov of the Soviet Academy of Sciences.

After Lt. Col. John H. Glenn's orbital flight last month, Premier Khrushchev made a general recommendation for U.S.-USSR cooperation in space in his congratulatory message to the U.S. Kennedy replied on May 7 with a letter that contained these proposals:

- **Meteorological satellite system** be established, with the U.S. and USSR each placing such a satellite into near polar orbits in planes approximately perpendicular to each other. Data gathered from the satellites would be made available to the world.
- **Tracking stations** be established and equipped by each country in the other's territory, with the latter providing the operating personnel. Thus the U.S. would provide equipment for Soviet technicians to use on Russian soil in the tracking of both U.S. and USSR spacecraft. The Soviets would do the same in the U.S.
- **Mapping** of the earth's magnetic fields be accomplished by one U.S. and one Soviet satellite, with one in a low earth orbit and the other at a much higher altitude.
- **Communications satellites**, with the USSR joining other nations planning to participate in U.S. programs.
- **Pool of space medicine data** on the basis of common interest in manned space flight and the universal desire to ensure man's survivability in a space environment.

Last week, Khrushchev agreed to cooperate with the U.S. in the exploration of space, but emphasized that such joint efforts would depend to some extent on progress made in disarmament. Failure to reach an agreement on general and complete disarmament, he told the U.S. President in his letter, limited both nations' ability to effectively cooperate in space.

Khrushchev's letter embodied six proposals, four of which—meteorological, communications, tracking and magnetic-field mapping—approximated those points in Kennedy's message. The Soviet premier made no mention of a space medical data pool, but instead called for agreement on a common approach to legal problems arising out of space exploration and on rendering aid to spacecraft in distress.

Kennedy, at a conference last week, described himself as "gratified" by Khrushchev's constructive response.

Of the various areas of possible cooperation listed by Kennedy and Khrushchev, meteorological and communications satellites were emphasized by U.S. and Soviet delegates in the United Nations Committee on the Peaceful Uses of Outer Space last week—giving rise to speculation that these might be the first joint space efforts negotiated between the two countries.

The UN space committee, meeting for its first working session since its revival last year (AW Dec. 18, p. 32), also heard from David A. Davies, secretary general of the World Meteorological Organization (WMO), a special UN agency. Davies reported on his organization's progress in the formulation of a report on weather science and forecasting as requested last year by a UN General Assembly resolution.

Administration Is Ready to Modify Its Stand on Comsat Ownership

Washington—Administration attempted last week to curb increasing congressional support for ownership of a communications satellite system by a small group of communications common carriers—with American Telephone & Telegraph Co. dominant—by volunteering to modify its own proposal for broad-based public ownership (AW Feb. 12, p. 26).

Attorney General Robert F. Kennedy spearheaded the new move in testimony to House commerce committee.

The new plan discussed at the session would involve financing by one class of stock—with a percentage of the total subscription reserved for communications carriers and the remainder available to the general public.

Rep. Oren Harris (D.-Ark.), chairman of the committee, suggested this type ownership and Kennedy said he thought it "would work out."

The probable controversy will be over the percentage division. Harris proposed more than 50% for the carriers. The Administration would agree to no more than a 50% ownership by the carriers, a spokesman told AVIATION WEEK.

Under the Administration's original plan there would be two classes of ownership. Class A stock, carrying voting rights and eligible for dividends, could be purchased by anyone including communications common carriers. Class B stock would be available only to the carriers and their investment in it could be included in their rate base. It would pay no dividends and carry no voting rights.

Under this plan, Harris noted, it would be theoretically possible for the communications carriers to buy all of the Class A stock. Kennedy estimated the cost of the initial commercial satellite system at between $100 and $400 million—it is too early to tell.

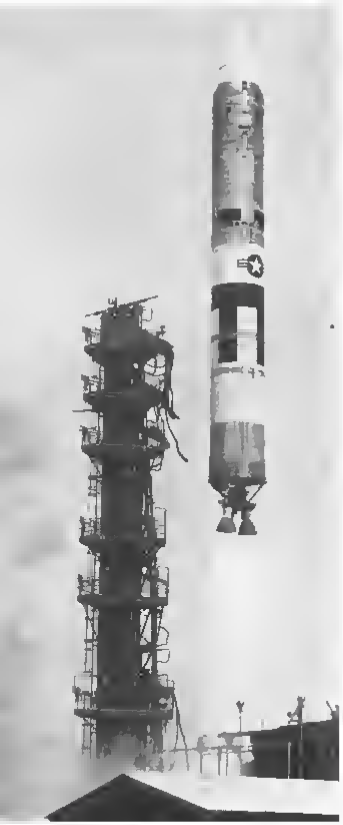
In his testimony Kennedy repeatedly emphasized that the Administration is not wedded to specific provisions in its original proposal. He expressed the hope that by working together, the Administration and Congress could achieve the best possible ideas and the best possible language for legislation establishing a private monopoly to develop and operate the system.

Kennedy, however, was firmly opposed to all carrier ownership and domination by AT&T. Carrier ownership has been vigorously urged by Federal Communications Commission, as well as by AT&T and other carriers (AW May 12, p. 31).

The compromises which Kennedy agreed to make in controversial points of the original proposal were:

- **Reduce the price** of stock offered the public to $100 from the $1,000 a share for Class A stock under the President's original plan.
- **Permit communications** carriers to build and own their own ground stations for the satellite system. Under the President's plan these would be owned by the satellite system corporation.
- **Lessen the extensive** authority of the U.S. President to direct and intercede in the functioning of the private satellite corporation.
- **Recast the role** of the State Department to that of foreign policy adviser and policy director for the satellite corporation rather than the negotiator with foreign governments.

Committee members—who had previously shown strong support for all carrier ownership—were receptive to Kennedy's compromise approach.



First Titan 2 Launched

First USAF Martin Titan 2 missile flew 5,000 mi. over the Atlantic Missile Range Mar. 16 in the first flight test of the new vehicle which uses storable propellants and will be launched from underground silos on operational use. Test objectives were to evaluate the Aerojet-General Corp. propulsion system which uses two 215,000-lb.-thrust engines in the first stage and one 100,000 lb. thrust engine in the second; staging technique; general flight performance accuracy and distance. USAF said all objectives were met. Titan 2 also carried the first General Electric Mark 6 re-entry vehicle to be flight tested. The missile later will boost the two-man Gemini capsule for development of rendezvous techniques and become the core of a larger space vehicle that will employ solid propellant boosters and high energy upper stages (AW Feb. 19, p. 28).

Khrushchev Claims New 'Global Rocket'

Moscow—Enormous sums spent by the U.S. for ballistic missile early warning systems and on anti-missile projects have been wasted because Russian scientists have created a new global missile that is invulnerable to anti-missile weapons and can approach the U.S. along any trajectory—including one across the South Pole—Soviet Premier Nikita Khrushchev said.

Khrushchev did not say such a missile would either go into a partial earth orbit or become an orbiting warhead before descending on its target. But he noted that the U.S. had built early warning radar sites (the Ballistic Missile Early Warning System) and other installations near the North Pole to intercept rockets flying the shortest trajectory from Russia and said: "The new global rocket can fly around the world in any direction and deal a blow at any set target."

Francis Gary Powers' Lockheed U-2 reconnaissance aircraft flew from Pakistan to Sverdlovsk to have a look at the area where it was assumed our intercontinental missiles were situated—where they were supposed to be according to their calculations since this is the shortest trajectory for firing intercontinental missiles," Khrushchev said.

"Even if it is assumed that the American military were right in their calculations we can now fire from those positions not across the North Pole but in the opposite direction."

Manned Flights May Await New Sputniks

Moscow—Soviet Union's launching of the first in a new series of scientific earth satellites on May 16 could mean that the orbiting of the next Russian cosmonaut will not be attempted until the satellites have made a more detailed survey of conditions affecting manned flight.

For four and a half years Russia has followed a pattern of launching its satellites and space probes in series having related missions. Only once has it interrupted the launching of a series with one type of mission to fire satellites with a different type of mission.

The orbit of the satellite launched Mar. 16 has an inclination to the equatorial plane of 49 deg. instead of the standard 64-65 deg. used for all earlier Russian satellites. Russia also revealed less detail about the main mission of this satellite than it has for any other except the one that preceded the orbital launch of a space probe to Venus early last year (AW Feb. 13, p. 28).

The official news agency Tass said the new series of "artificial earth satellites"—the same term used for the first three Russian Sputniks—will be launched "from different cosmodromes of the Soviet Union during 1962."

Apogee of 609.07 mi. and perigee of 134.87 mi. for the new Sputnik are similar to those of the first three Russian satellites. Sputnik 1 had an apogee of 558 mi. and a perigee of 142 mi., Sputnik 2 had an apogee of 1,038 mi. and a perigee of 140 mi., and Sputnik 3 had an apogee of 1,167 mi. and a perigee of 135 mi. Initial period of the new satellite is 96.35 min. Russia said the satellite is transmitting on 20.003 and 90.018 mc.

Orbit of the latest Sputnik should give it a long enough lifetime to cover the U.S. nuclear test series that is to begin in the Pacific Ocean next month. Although Russia did not specify what instrumentation this satellite carries, Tass said one function of the new series will be the study of the distribution and formation of ionic patterns in the earth's atmosphere"—indicating that infrared devices and television cameras might be aboard.

Some U.S. observers believe Russia may have separate task forces working on scientific earth satellites, lunar and planetary probes and manned spacecraft just as this country does.

While it does not seem likely that flights of Soviet cosmonauts would be delayed until a long series of scientific satellites had been flown, it may be that Russia wants to investigate specific problems before making more manned flights.

Prof. Nikolai Pushkov, director of the Institute of Terrestrial Magnetism, Ionosphere and Propagation of Radio-waves of the USSR Academy of Sciences was quoted by Tass as saying that the new program envisions solutions to all vital problems raised by previous space research.

Senate to Investigate Missile Costs, Profits

Washington—First of a series of public hearings on charges of excessive costs and profits in missile procurement will start Apr. 3. Sen. John McClellan (D-Ark.), chairman of the Senate Permanent Subcommittee on Investigations, said last week.

The group will endeavor to evaluate the Army's "in house" management of missile programs as against Air Force's weapons system procurement, under which industry is delegated a greater degree of management responsibility.

Contractors slated to testify mainly on the three following programs are:

- **Army Nike** air defense program—Western Electric Co. and Douglas Aircraft Co. This was managed by Army Ballistic Missile Agency, now the Army Ordnance Missile Command.
- **Atlas intercontinental** ballistic missile program—General Dynamics Astronautics the prime contractor. USAF obtained technical direction from Space Technology Laboratories, now Aerospace Corp.
- **Bomarc air defense program**—Boeing Co., Westinghouse Electric Corp., Aerojet-General Corp., Thiokol Chemical Corp., and International Telephone and Telegraph Co. Boeing was the prime contractor.

Lear, Inc., FMC Corp., Fruehauf Trailer Co., and Consolidated Western Steel Division of United States Steel Corp. are also scheduled to appear. Other companies will be called.

Defense Considering TFX vs. F4H-1 Study

Washington—Defense Department has added a note of uncertainty to the proposed Air Force-Navy TFX tactical fighter (AW Feb. 19, p. 31) by considering a cost effectiveness study comparing it with the McDonnell F4H-1, which is being purchased in quantity by the two services.

The study would apply a rule that Defense Secretary Robert S. McNamara is increasingly employing in comparing proposed new weapon systems with those currently operational. The percentage of increase in cost of the new system over the old cannot exceed by more than 20 times the percentage of increase in performance capability. For example, a 5% increase in performance capability would not be permitted to result in more than a 100% increase in cost.

Defense last week confirmed that the Pratt & Whitney TF-30 turbofan engine has been chosen to power the TFX which has been redesignated the F-111A. The engine's military designation is the JTF10A-20.

Pentagon sources said the delay in announcing the choice (AW Feb. 26, p. 25) was due to high level Air Force objections to being told by the Defense Department to use a Navy-developed engine and having it produced in a Navy controlled plant. Air Force had encouraged the General Electric Co. to design an engine for its original TFX project, which was later ordered by Defense to be combined into the bi-service project.

Final design competition on the F-111A has been narrowed to The Boeing Co. and General Dynamics Corp. Boeing, whose original proposal was built around the General Electric Mf.295 engine, was told Jan. 30 to alter its design to incorporate the JTF10A (AW Feb. 12, p. 28). The JTF10A is 2 in. greater in diameter and slightly longer than the Mf.295, and weighs more. Forcing the JTF10A on Boeing whose design for the F-111A was considered best, was another source of Air Force irritation.

The JTF10A, originally developed to power the Navy's canceled Missileer aircraft has been flight tested in a pod hung from the fuselage of a B-45 bomber over the Hartford, Conn., area. The Pratt & Whitney plant is located in East Hartford.

Specifications state that engine without afterburner produce 10,750 lb. of thrust; military rating. With afterburner the thrust requirement is 18,500 lb. Development growth has already raised the thrust without afterburner to more than 12,000 lb. By the time the engine goes into production it will probably produce 14,000 lb. of thrust without afterburner. Installed weight will be about 3,500 lb., but this will not become firm until the development cycle of the airframe is almost completed.

The F-111A program over the next eight years is expected to reach $4.5 billion of which $800 million would be spent on engines.

Another engine the Allison AR168, a version of the British Spey, was in the engine competition, but was not included as the first choice of any of the six TFX designs originally submitted.

DOD Research Unit Gains New Deputies

Washington—Number of deputy directors in the office of Dr. Harold Brown, director of defense research and engineering, has been increased from three to six in the most recent reorganization of the office, whose influence over weapon systems decisions has grown more powerful in the Kennedy Administration.

Deputy director weapon systems has been split into two offices—deputy director strategic and defense systems and deputy director tactical warfare systems. Dr. Marvin Stern headed both offices temporarily before resigning Mar. 23.

Another new office, deputy director engineering and chemistry, under Dr. J. H. Gardner has also been established. Its scope will include engineering, materials, chemical technology and biological and chemical warfare.

Dr. Eugene G. Fubini, formerly deputy director research now is deputy director research and information systems.

Vice Adm. C. B. Martell, who formerly headed the directorate of administration, now has the title of deputy director-administration and management.

News Digest

Scandinavian Airlines System returned its fleet of 20 Sud Caravelles to service last week after several days' grounding ordered after the main undercarriage of an SAS Caravelle collapsed as it taxied to takeoff position on a planned Copenhagen-London flight.

World-wide telephone communication plan consisting of placing nine satellites in an equatorial circular orbit has been submitted to the British government by an industrial consortium of 11 major British electrical firms. Cost for the system is estimated at $600 million and cooperation of British Commonwealth nations is considered a requisite.

Contracts exceeding $1 million have been received by Aerolab Development Co. for rocket development work. Included is a development and fabrication subcontract from Raytheon Co. as part of Advanced Research Projects Agency Arpat program for terminal defense against ICBMs, and Argo D-4 and D-8 configurations for NASA's Goddard Space Flight Center. Air Force Cambridge Research Laboratories, and Electro-Optical Systems, Inc.

Motorola's Military Electronics Division Scottsdale, Ariz., has been selected by Jet Propulsion Laboratory to build S-band radio receivers and transmitter exciters for its Deep Space Instrumentation Facility after a hotly contested competition (AW Mar. 5, p. 15; Feb. 5, p. 59). Contract is for $1 million.

Titan 3 inertial guidance proposals were submitted to Air Force last week by a number of avionics organizations, including Northrop, Autonetics, General Electric and a team of Space Technology Laboratories and American Bosch Arma.

Teamsters Union, by a vote of 2,431 to 2,064, won a representation election on Mar. 21 at the Stratford and Bridgeport, Conn., plants of United Aircraft Corp.'s Sikorsky Aircraft Division. An earlier Teamster victory at Sikorsky was voided by the National Labor Relations Board (AW Mar. 5, p. 26).

North American Aviation, Inc., has been awarded a $67,725,443 Navy contract to produce a tactical reconnaissance version of the A3J-1 Vigilante twin-engine Mach 2 bomber.

Delta, Trans World National, Northeast and Northwest airlines last week filed vigorous protests asking the CAB to suspend and investigate Eastern Air Lines' proposed low-fare tariff package (AW Mar. 5, p. 30).

American Initiated Merger Discussions

Airlines tell CAB Eastern was seeking possible consolidations; Rockefeller served as intermediary.

Washington—First overtures toward an American-Eastern merger were made by American Airlines at a time when Eastern was shopping for consolidation possibilities with other carriers.

In a joint response filed last week with the Civil Aeronautics Board, in answer to a request for information by CAB bureau counsel and interested parties, American said that on Oct. 10 it had asked Laurance S. Rockefeller to serve as an intermediary in sounding out Eastern's reaction to a merger proposal. American said it did not wish to approach the carrier directly unless there was reason to believe that Eastern would be interested.

Later a series of meetings was held between the two airlines, culminating in a definitive agreement signed on Jan. 22 (AW Jan. 29, p. 36). During this period, Eastern approached TWA with a merger proposition and top officials of these two airlines met on Dec. 4 to discuss details (AW Jan. 15, p. 38).

Details of Report

Other facts disclosed in the report filed with the CAB include:

- **Eastern forecast** a substantial profit for itself in 1962 and subsequent years but, during exploratory talks, American did not agree with these predictions. In a forecast filed with financial institutions, Eastern assumed that its earnings during the next eight years would be $10 million annually.
- **In the forecast,** which was prepared prior to the merger talks Eastern estimated its working capital balance would reach a high of $38.8 million with a cash balance of $59.1 million by the end of 1962, but would taper off to a working capital deficit of $72 million and a cash deficit of $52.2 million at the end of 1965, after accepting delivery of 40 Boeing 727 transports beginning in late 1963. However, by 1965, senior debt will have been reduced to $104 million, which, under minimum debt ratios, would increase allowable borrowing power to $100 million to offset working capital losses.
- **American has agreed** to give seven Eastern officers executive positions in the merged company if the officers agree to stay with the merged airline for 18 months after the effective date of the merger. Following the 18-month period each will receive at least three years' salary at a rate not less than that in effect with Eastern on Jan. 1, whether he remains with the merged company or not.
- **Carriers were unable** to fix a set market value for used aircraft, although both were of the opinion that the market value of jet aircraft is at least equal to the book value—original cost less depreciation. Recent aircraft prices paid by American include a Lockheed Electra $1.7 million, a Douglas DC-7B, $315,000, a DC-6B, $325,000, and a Convair 240, $147,000. Eastern sold 14 Lockheed 749s at $50,000 each in January, 1961 and, more recently, 10 Martin 404s at prices ranging from $62,000 to $122,000 each.
- **Merged company** will improve the Boston-New York-Washington Air Shuttle by placing Lockheed Electras into service. First class service will be limited to four round trips daily on the route.
- **Two companies now employ** a total of 42,000 persons. In 1961, new vacancies created by resignations, retirements and other causes were 4,692. Personnel reductions caused by the merger will be substantially less than annual losses from turnover.

Eastern's minutes of the board of directors meeting on the merger disclosed that the company's management had studied the possibilities of mergers with several airlines as a means of offsetting the airline's problems of short routes, short-haul flights and "the excessive amount of multiple competition which has been superimposed upon Eastern in recent years."

Rockefeller, who holds 93,636 shares of Eastern common stock or 2.90% of all outstanding common shares, agreed to discuss the merger proposal with Eastern after he was approached on the subject by Manly Fleischmann, an American director. Fleischmann acted on the request of C. R. Smith, American president.

Talks with Rockefeller

Rockefeller talked to Eastern's Board Chairman E. V. Rickenbacker, who will retire when the companies are merged (AW Mar. 19, p. 41), and Eastern President Malcolm A. MacIntyre. They showed interest and asked Rockefeller to explore the matter further.

On Oct. 17, a meeting was held in Rockefeller's office where actual discussions began between Rockefeller, Harper Woodward—an Eastern director—Fleischmann, Smith and William J. Hogan, American's executive director of finance. No definite proposals were made by either side but a strong interest in continuing discussions was shown by all parties.

On Oct. 25, the first proposals for the basis of a stock exchange was made by American at a meeting held in Smith's New York apartment. This offer called for an exchange of six shares of American stock for five of Eastern, or a ratio of 1.20 to 1. In subsequent meetings, Eastern revealed that the American offer was unacceptable.

American then supplemented the 1.20 exchange ratio by an offer to give warrants to Eastern's shareholders to the extent that Eastern was able to show profits by the end of 1962 or by the effective date of the merger, which ever was earlier. If Eastern's earnings were between 50 cents and $1.50 per share during this period, each share of Eastern would receive, in addition to the 1.20 shares of American stock, a warrant to purchase one-third of a share of American stock.

If earnings were more than $1.50, a warrant to purchase two-thirds of a share of American stock would be granted each Eastern share. But Eastern continued to show dissatisfaction with the 1.20 ratio.

American then increased the ratio to 1.25, but also boosted the earnings minimum for the issuance of warrants. Eastern, however, still balked at the ratio and finally, on Jan. 5, Eastern accepted an American proposal for a 1.30 exchange ratio, plus a warrant to buy one-third of a share at $28 per share. Definitive contract was presented to the board of directors of each company on Jan. 23 and signed on that date.

Trunklines' 1961 On-Time Performance

Carrier	Total flights (non-stop and one-stop)	On time or within 15 min. of schedule	
		Number	%
Eastern	63,234	53,006	83.83
Braniff	15,245	12,376	81.18
American	70,548	55,049	78.03
Trans World	35,897	27,160	75.66
United	66,674	50,280	75.41
National	8,499	6,352	74.77
Continental	16,950	12,611	74.40
Western	13,142	9,001	68.49
Northeast	28,186	19,272	68.37
Delta	23,336	15,109	64.76
Northwest	8,628	5,319	61.65

Source: Civil Aeronautics Board

Engineer-Pilot Issue Centered at Pan Am

Washington—Flight Engineers International Assn.'s announced plan to strike Pan American World Airways Friday after 21 months of negotiation and a year of government study is being viewed as a test case which could lead to an industry-wide settlement of the crew complement issue.

No progress in negotiations over the final acceptance of the Feinsinger Report (AW Oct. 23, p. 35) was noted by either the airline or union late last week and FEIA continued to maintain that it would walk out Friday.

The threat of a complete shutdown of all U.S. international operations by FEIA was narrowly averted earlier in the week when a special presidential emergency board was appointed to head off a strike against Trans World Airlines. Under the terms of the Railway Labor Act this action automatically delays a strike against TWA for 60 days.

TCA Deficit

Trans-Canada Air Lines reported a 1961 deficit of $6,450,082, the largest loss in the airline's 25-year history. The airline cited "deterioration in average revenue per passenger miles flown," and shifts in Canadian travel habits as reasons for the loss.

Congress' Interest in Southern Pilots' 21-Month Strike Intensifies

Washington—Congressional interest in the 21-month strike of Southern Airways pilots intensified last week as the airline prepared to defend its position before a special presidential labor authority and the union announced its abandonment of a competing air taxi service established by the strikers.

Rep. Frank Kowalski (D-Conn.), a strong advocate of controlling federal subsidy payments, has introduced legislation to deny subsidy to any airlines that do not make "reasonable efforts" to settle labor disputes.

Kowalski's Statement

In an earlier telegram to Prof. Nathan B. Feinsinger, who was appointed by the White House to investigate the strike, Kowalski said, "If an industry is involved in a labor dispute such that it incurs losses directly attributed to this dispute, under no circumstances should the government allow public funds to be used to underwrite these losses" (AW Mar. 5, p. 32).

Sen. Estes Kefauver (D-Tenn.) has also taken an interest in the investigation. Part of the evidence submitted by the Air Line Pilots Assn. during the hearings included a letter from Kefauver urging Feinsinger to investigate each individual complaint about Southern's non-union replacement pilots. The senator said he had asked the Federal Aviation Agency to produce their findings on these complaints but the Agency failed to comply. Feinsinger said he would determine later whether the FAA should produce this information.

ALPA's Case

ALPA has contended that Southern intentionally failed to bargain in good faith as required under provisions of the Railway Labor Act and that the company further refused to rehire the striking pilots after general contract terms had been agreed to by both parties. Acceptance of a Southern demand that returning strikers assume a lower seniority listing than the present pilots amounts to "punitive action" on the part of the company, the union said.

The airline is tentatively scheduled to defend its position this week, but resumption of the hearings may be delayed because of other airline labor problems being investigated by Feinsinger.

ALPA has also charged that the use of non-union pilots by Southern has resulted in an unsafe airline operation. FAA countered that Southern has had an "unusually good" safety record during the strike. Out of a total 345 complaints filed against the carrier, mostly by ALPA, the Agency said that 200 charged on-time violations. FAA said investigation disclosed actual violations in only two cases. Since the beginning of the strike on June 5, 1960, the Agency testified that it has acted in five cases involving violations of Civil Air Regulations by the airline, and 14 violations by individual pilots of the airline.

Meanwhile, the union has disclosed the sale of its interest in Superior Airways, an air taxi operation, after more than a year of unprofitable competition against Southern. Established in December, 1960, by a group of the strikers, Superior employed 30 pilots and operated seven twin-engine seven-passenger de Havilland Dove aircraft. Neither the union's initial investment in the venture nor the final sales price was disclosed by ALPA spokesmen.

Eastern Operation Sold

The eastern portion of the Superior operations was sold to the Parker Oil Co., of Ozark, Alabama. Parker will retain the Superior name and keep the air taxi headquarters in Atlanta to serve Georgia and Alabama points, the union said.

Balance of the air taxi operation has been assumed by Trans Air Lines, an air taxi operator based in New Orleans and providing service throughout Louisiana.

Further details of the transaction, concluded Mar. 1, were not disclosed but it is believed that the sale included only the Superior operating authority and ground equipment. The fleet of de Havilland aircraft is understood to have been purchased outright by the union, and was not made a part of the recent sales agreement.

Trunklines' 1961 Loss

Washington—U.S. trunkline losses for 1961 exceeded $34 million, compared with a net profit of $1.1 million in 1960 according to Air Transport Assn. figures.

Operating revenues for 1961 were $2.026 billion while operating expenses were $2.019 billion, giving an operating profit of $6.3 million. However, non-operating expenses, taxes and special items reduced this figure to a loss of $34,053,000.

For January, 1962, the trunklines lost $5.7 million compared with a $4 million loss for the same period last year, ATA said.

U.S. Domestic, International Airline Operations & Traffic Statistics 1961

	Revenue Aircraft Miles (000)	Revenue Passengers	Revenue Passenger Miles (000)	Available Seat Miles (000)	Average Length of Journey	Average Passenger Load	Average Available Seats	Passenger Load Factor (%)	Revenue Ton Miles (000)
DOMESTIC SERVICE									
American	118,276	7,612,345	5,[illegible]	[illegible]	724	50 4	81 9	62	734,676
Braniff	31,008	2,247,928	1,069,938	1,851,867	476	34 5	59 7	58	121,036
Continental	24,500	1,336,855	902,134	1,896,980	675	36 8	77 5	48	98,534
Delta	51,255	3,646,840	2,168,474	3,677,859	600	42 7	71 8	60	241,681
Eastern	110,098	7,758,683	4,006,971	7,957,476	516	36 4	72 3	50	436,562
National	25,082	1,652,271	1,136,921	2,083,757	688	45 3	83 1	55	127,315
Northeast	21,273	1,647,184	752,208	1,496,852	457	35 4	70 4	50	77,921
Northwest	23,733	1,444,204	1,025,538	1,911,592	710	43 2	80 5	54	118,729
Trans World	85,588	4,693,547	4,286,648	7,545,197	913	50 1	88 2	57	497,490
United Capitol	170,459	11,360,856	7,495,764	13,071,421	660	44 0	76 7	57	889,118
Western	18,903	1,475,275	873,733	1,575,038	592	46 2	83 3	55	92,156
Trunk Total	680,195	44,875,988	29,702,854	52,762,048	662	43 7	77 6	56	3,435,218
[illegible]									
[illegible]	[illegible]	84,2[illegible]	[illegible],41	1,082	40 1	75 5	53	13,180
Braniff	3,673	111,458	165,52	312,616	1,482	45 0	85 2	53	19,561
Caribbean	1,626	439,701	31,039	47,228	71	19 1	29 0	66	3,053
Delta	797	17,056	21,214	58,138	1,244	26 6	72 9	36	2,443
Eastern	12,203	506,927	750,115	1,159,078	1,480	61 5	95 0	65	76,761
Mackey	888	122,822	21,893	50,883	178	24 7	57 3	43	2,240
National	43	3,603	1,953	3,475	542	45 1	80 2	56	211
Northwest	7,925	197,859	376,232	744,059	1,902	47 5	93 9	51	68,273
Panagra	4,517	130,545	229,749	370,181	1,760	50 9	82 0	62	33,991
Pan American	101,305	3,506,861	6,191,743	10,438,941	1,766	61 0	102 8	59	883,548
South Pacific	295	2,470	6,747	16,819	2,732	22 9	57 0	40	715
Trans Caribbean	2,405	108,764	170,512	225,319	1,568	70 9	93 7	76	17,356
Trans World	17,793	302,066	956,610	1,977,916	3,167	53 8	111 2	48	142,319
United	6,337	185,232	461,185	743,319	2,490	72 8	117 3	62	53,556
Western	1,721	53,862	83,827	143,816	1,556	48 7	83 6	58	9,076
International Total	164,051	5,775,447	9,561,220	16,467,449	1,655	58 3	108 4	58	1,326,683
LOCAL SERVICE									
Allegheny	9,779	827,274	172,[illegible]33	392,609	209	17 6	41 1	43	18,176
Bonanza	4,397	316,559	79,888	167,047	252	18 2	38 0	48	7,961
Central	5,743	243,047	47,739	135,654	196	8 3	23 6	35	5,125
Frontier	9,437	358,138	97,982	254,999	274	10 4	27 0	38	10,699
Lake Central	6,658	399,077	64,204	184,642	161	9 6	27 7	35	6,725
Mohawk	8,502	789,004	162,149	364,278	206	19 1	42 8	45	16,532
North Central	15,211	1,010,508	187,823	436,319	186	12 3	28 7	43	19,999
Ozark	8,789	569,431	102,807	238,310	181	11 7	27 1	43	10,887
Pacific	5,297	448,078	104,907	216,222	234	19 8	40 8	49	10,380
Piedmont	7,804	498,913	105,941	230,651	212	13 6	29 6	46	10,844
Southern	8,213	392,776	71,300	215,647	182	8 7	26 3	33	7,604
Trans-Texas	7,725	321,657	74,896	202,133	233	9 7	26 2	37	8,077
West Coast	6,774	379,171	93,591	217,261	247	13 8	32 1	43	9,469
Local Total	184,349	6,354,433	1,365,789	3,265,302	288	13 1	31 3	42	142,428
ALASKA & HAWAIIAN									
Alaska Airlines	4,032	92,733	53,59	179,536	897	27 4	59 3	46	15,123
Alaska Coastal	1,081	57,460	5,840	10,105	102	5 4	9 3	58	711
Aloha	2,103	356,387	53,717	84,498	151	25 5	40 2	64	4,405
Cordova	835	24,474	3,849	7,946	158	4 6	9 5	49	897
Ellis	766	54,967	3,421	6,657	62	4 5	8 7	51	406
Hawaiian	3,247	483,111	73,831	121,293	153	22 7	37 4	61	9,110
Kodiak	332	11,858	750	1,857	63	2 3	5 6	40	92
Ne Consolidated	1,735	31,609	9,966	25,561	315	5 7	14 7	39	2,647
Pacific Northern	4,616	130,186	122,629	248,459	942	26 6	53 8	49	20,619
Reeve Aleutian	1,184	15,790	14,846	36,189	940	12 5	30 6	41	3,525
Western Alaska	356	9,329	476	702	51	1 3	2 0	68	83
Wien Alaska	2,826	45,383	14,024	30,554	309	5 0	10 8	46	3,483
Alaska & Hawaiian Total	22,113	1,313,287	386,528	753,677	294	17 5	34 1	51	60,101
HELICOPTER									
Chicago	1,018	245,506	4,225	10,[illegible]75	17	4 2	10 0	42	422
Los Angeles	669	41,468	1,507	2,754	36	2 3	4 1	55	230
New York	504	149,846	2,941	5,483	20	5 8	10 9	54	317
Helicopter Total	2,191	436,820	8,673	18,412	20	4 0	8 4	47	869
CARGO & OTHER									
AAXICO	3,156	3,370	723	9,840	215	0 2	3 1	7	26,903
Aerovias	525								2,891
Avelon	421	81,104	3,830	7,751	47	9 1	18 4	49	378
Flying Tiger	12,672	47,474	217,843	303,019	4,589	17 2	23 9	72	159,879
Riddle	15,288	44,637	234,760	253,044	5,259	15 4	16 6	93	102,010
Seaboard	7,433	44,054	172,565	172,590	3,917	23 2	23 2	100	80,706
Slick	4,789	21,238	130,801	138,506	6,159	27 3	28 9	94	55,866
Cargo etc Total	44,284	241,877	768,522	884,750	3,144	17 2	20 9	86	428,533
INDUSTRY TOTAL	1,017,183	59,197,852	41,785,586	74,152,139	706	41 1	72 9	56	5,393,932

	Available Ton Miles (000)	Average Ton Load	Overall Load Factor (%)	No of Departures	Average Length of Hop	Revenue Hours	Off-On Speed (m.p.h.)	No of Employes	No of Aircraft
DOMESTIC (TRUNK)									
American	1,344,162	6 2	55	277,323	427	374,973	315	23,442	175
Braniff	256,770	3 9	47	128,656	241	125,754	247	4,962	60
Continental	249,020	4 0	40	85,413	287	81,847	299	2,918	27
Delta	479,782	4 7	50	162,834	280	191,843	267	8,506	77
Eastern	1,089,801	4 0	40	459,867	239	445,672	247	17,420	198
National	303,155	5 1	42	85,658	293	88,934	282	4,125	48
Northeast	186,100	3 7	42	86,668	245	84,068	253	2,917	33
Northwest	252,806	5 0	47	66,867	355	78,570	302	5,115	42
Trans World	1,058,228	5 8	47	171,773	498	269,766	317	17,236	134
United/Capitol	1,747,730	5 2	51	502,011	340	594,751	287	30,580	269
Western	206,625	4 9	45	64,350	294	64,801	292	2,759	35
Trunk Total	7,176,179	5 1	48	2,111,420	322	2,400,978	283	119,980	1,008
[illegible]									
American	26,798	5 7	49	3,067	757	6,632	350	246	2
Braniff	43,317	5 4	46	3,685	997	10,546	348	536	4
Carlair	4,765	1 9	64	23,714	69	12,039	135	369	8
Delta	6,987	3 1	35	1,172	680	2,792	285	31	2
Eastern	130,281	6 3	59	8,588	1,421	39,599	308	144	14
Mackey	5,325	2 5	42	9,797	91	4,909	181	137	6
National	426	4 9	50	96	451	187	232		
Northwest	114,499	8 6	60	6,402	1,238	20,947	378	689	11
Panagra	56,458	7 5	60	5,360	843	13,052	346	1,191	11
Pan American	1,591,092	8 7	56	107,079	948	267,788	379	19,747	113
South Pacific	1,807	2 4	40	108	2,733	1,021	289	31	1
Trans Caribbean	23,187	7 2	75	1,705	1,411	9,281	259	299	2
Trans World	289,618	8 0	49	12,382	1,437	44,537	400	2,385	18
United	99,533	8 5	54	2,544	2,491	11,998	528	482	4
Western	18,194	5 3	50	1,106	1,556	5,037	342	35	2
International Total	2,412,287	8 1	55	186,805	878	458,365	364	26,322	188
LOCAL SERVICE									
Allegheny	39,095	1 8	46	89,664	109	56,516	173	1,312	35
Bonanza	16,266	1 8	49	34,676	127	20,950	210	515	9
Central	15,166	8 9	34	68,405	84	38,358	150	733	22
Frontier	25,684	1 1	42	90,998	104	57,682	164	1,096	31
Lake Central	18,577	1 0	36	87,505	76	46,843	142	840	27
Mohawk	38,647	1 9	43	80,341	106	49,536	172	1,465	32
North Central	44,876	1 3	45	186,907	81	100,156	152	2,012	42
Ozark	22,590	1 2	48	99,637	88	58,688	150	1,086	26
Pacific	21,178	2 0	46	51,097	104	29,270	181	658	23
Piedmont	22,776	1 4	48	91,347	85	49,262	158	1,181	25
Southern	21,730	0 9	35	96,614	85	53,912	152	991	29
Trans-Texas	21,065	1 0	38	79,014	98	47,889	161	827	31
West Coast	21,732	1 4	44	73,347	92	42,028	161	761	21
Local Total	328,382	1 4	43	1,129,552	92	651,090	160	13,479	353
ALASKA & HAWAIIAN									
Alaska Airlines	24,728	5 0	61	7,673	395	12,731	238	538	8
Alaska Coastal	1,101	0 7	65	18,003	60	9,575	113	143	15
Aloha	8,201	2 1	54	18,637	113	10,731	196	474	6
Cordova	1,617	1 1	55	11,694	71	6,754	124	67	12
Ellis	666	0 5	61	17,102	45	6,402	120	106	8
Hawaiian	13,417	2 5	60	27,654	117	18,116	179	657	12
Kodiak	235	0 3	39	9,681	34	4,451	75	21	6
Ne Consolidated	4,389	1 5	60	19,798	88	11,743	148	273	14
Pacific Northern	31,753	4 5	65	11,543	400	20,299	227	624	10
Reeve Aleutian	5,831	3 0	60	5,415	219	6,958	170	103	8
Western Alaska	132	0 2	63	9,292	38	3,448	103	23	6
Wien Alaska	6,497	1 2	54	29,294	96	19,684	144	264	30
Alaska & Hawaiian Total	98,567	2 7	61	185,796	118	130,892	169	3,283	135
HELICOPTER									
Chicago	1,191	0 4	35	72,587	14	12,330	83	197	8
Los Angeles	369	0 3	62	38,499	17	9,215	73	134	5
New York	623	0 6	51	38,857	13	8,713	58	245	6
Helicopter Total	2,183	0 4	44	148,843	15	30,258	72	576	18
CARGO & OTHER									
AAXICO	37,076	8 5	72	6,643	475	12,192	259	61	9
Aerovias	4,289	5 5	67	606	866	2,639	199	51	2
Avelon	736	0 9	51	9,813	43	3,097	136	27	8
Flying Tiger	204,874	12 6	78	11,256	1,126	47,163	269	1,175	17
Riddle	137,255	6 7	74	34,317	445	49,554	220	1,133	45
Seaboard	114,129	10 9	71	7,943	936	27,690	268	1,065	13
Slick	62,932	11 7	89	6,764	708	21,129	227	518	15
Cargo etc Total	561,291	9 7	76	77,342	573	183,464	241	4,030	109
INDUSTRY TOTAL	10,579,889	5 3	51	3,843,858	265	3,847,840	264	167,680	1,912

CAB Sifting 707 Flight Recorder Data for Clues to Crash Cause

By Glenn Garrison

New York—Intensive flight recorder ground and flight test study program to be conducted shortly by several segments of government and industry may provide further data on the behavior of an American Airlines Boeing 707-123B which crashed May 1 after takeoff from New York's Idlewild Airport.

Data from the recovered flight recorder as well as other information developed at a Civil Aeronautics Board hearing into the crash here last week, indicated nothing abnormal in takeoff and initial climb.

Summary of witness descriptions indicated the aircraft subsequently began a smoothly coordinated rather rapid roll to the left reaching a 90 deg left bank position. The roll began from a slightly nose high position—less than 10 deg. The roll continued less rapidly past 90 deg. the summary continued and the nose dropped through to a near vertical attitude.

Some witnesses disagreed on the attitude, one describing the nose rising to an angle of 30 deg., after which the airplane fell through to a dive angle of about 45 deg. Some witnesses likened the maneuver to a fighter pull off or then to a split S.

The damaged tape yielded data which CAB experts said indicated no unusual airspeed condition which might have led to a stall. Traces on the tape showed, according to CAB, that the 707's speed and headings were normal for the first 48 sec. after takeoff. The initial turn to 290 deg., to comply with anti noise procedures for Idlewild's Runway 31L, was begun about 12 sec. after the wheels were off. This heading was held to 800 ft. and at 26 sec. after takeoff the second prescribed turn—in this case to 160 deg.—was begun. At 48 sec. after takeoff altitude was 1,560 ft. and airspeed was 202 kt. This point appears on the traces at the 68-sec. point (see graphs).

From that point through the rest of the tape, the trace readings raise interpretation questions. From the altitude trace, it appears that the plane lost some altitude then gained more than it lost.

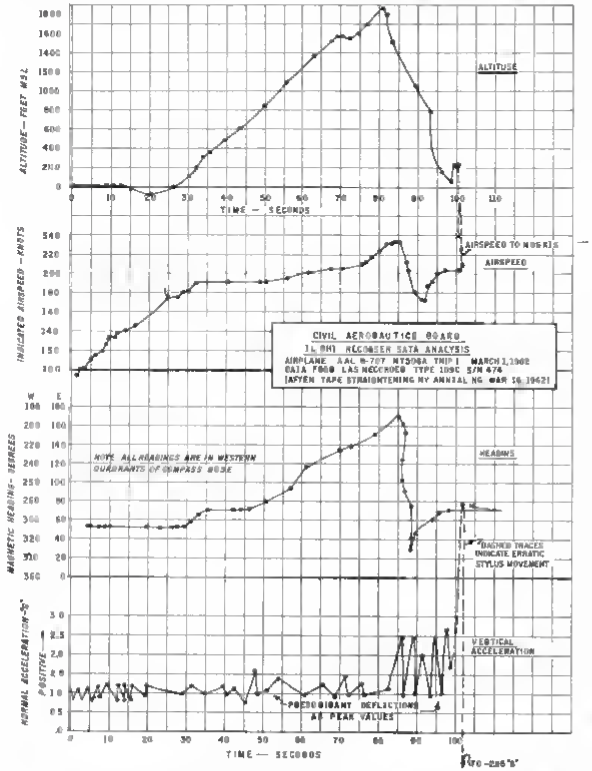
Questions to be answered by the test program include the effects of yaw on the altitude and airspeed traces and the effect of gyro tumble on the heading trace. CAB, Federal Aviation Agency and manufacturers, including Boeing, will participate. Findings of the program will increase the value of flight recorders as tools in accident investigations, pinpointing for example, normal maneuvers in an jet flight such as raising the landing gear.

The gyro installed in this 707, according to an expert, will reach its tumbling limit at about 70 deg. of roll or pitch. A combination of the two movements at lesser degree will produce the same effect. Tests will seek to determine the exact effects of tumbling on a recorder trace and to establish the response in each case. It might then be possible to tell by the trace whether the tumbling resulted from pure roll, pure pitch, or some combination of the two.

Another matter for further interpretation is the acceleration trace. As shown on the graph, a normal clutter appears as ground acceleration begins and the clutter ends at wheels off. During the normal portion of the flight, the graph responds to normal roughness of the air. At about the point where the other traces show unusual characteristics, the accelerometer trace shows very violent fluctuations, an interpretation of which is yet to be made.

There were two missing sections in the heading trace for which extrapolations were made. Correlation was made with tapes from other aircraft departing Idlewild 12 hr. before and after the fatal flight. Also comparisons were made with tapes from recorders in previous airline accidents.

According to testimony, flaps were fully retracted when the aircraft impacted. Jackscrews were up and two were broken. The powerplants group was able to say that the engines were capable of developing power at impact.



TRACES from flight recorder recovered from 707 wreckage indicate normal takeoff, turn and climb. Civil Aeronautics Board experts are certain of readings up to 68 sec. point, where altitude is 1,560 ft. and airspeed 202 kt.

U.S. Airlines Eye New Caribbean Nations

By L. L. Doty

Kingston, Jamaica—Forthcoming independence of Jamaica and Trinidad, and the strong possibility that eight smaller West Indies islands will unite in a separate federation, has raised new hopes for the future of U.S. airlines serving the growing Caribbean tourist area.

Award of a direct nonstop New York-Jamaica route to Pan American World Airways, following an agreement between U.S., Britain and West Indies is viewed here as a significant breakthrough in the expansion of U.S. airline service in the Caribbean. In the past, while Jamaica functioned as a colony, the British consistently frustrated U.S. bids to gain a foothold in the plush New York-Jamaica nonstop market, which Pan Am estimates will generate total revenues of $7.5 million this year.

Pan American's entry into this market represents only a single step forward—not necessarily an indication of future trends. The coming pattern of air routes throughout the Caribbean will be shaped by several factors, chief of which will be the political philosophies that will emerge with independence.

Originally, a West Indies Federation was planned for a majority of the chain of West Indies islands under British domination, but the Sept. 16 referendum decision by Jamaicans to quit the federation and accept independence forced Trinidad to follow suit. The smaller islands thus were left with no choice but to remain British colonies or form a federation of their own, since each is too small in area, population and resources to survive as an independent nation.

Jamaican Independence

Jamaicans, once they win Dominion status on Aug. 6 as members of the British Commonwealth, are determined to assert their rights as a nation to determine their air transport requirements. At one time, consideration was given to the establishment of a "paper" airline which would operate as a Jamaican flag carrier—in name only—with leased crews and equipment, but this has been dropped.

As a consequence, it now appears very likely that Jamaica, once it attains nationality, will not attempt to form a flag carrier, a move frequently made by newly established nations. Instead, it will look elsewhere for airline service required to serve it commercially and to build up tourism, which is rapidly expanding as a major industry.

Because the U.S. is a major source of tourist trade, U.S. carriers undoubtedly will be among the major beneficiaries of any route adjustments the Jamaicans may seek, despite Commonwealth ties with Great Britain.

No formal date has been set for the independence of Trinidad and Tobago. The islands, however, are intent on leaving the federation and accepting Dominion status. Upon effective, the Trinidad carrier—British West Indian Airways—will be in the competitive fight for business, once independence is attained, remains to be seen.

The government of Trinidad and Tobago took possession of BWIA on Nov. 1 with payment of $1.4 million to British Overseas Airways Corp., which operated the local carrier as a wholly-owned subsidiary at substantial losses (AW June 12, p. 42). The purchase price primarily covered route operating privileges, although one Vickers turboprop Viscount, three Douglas DC-3 transports and some property on certain islands were included in the sale.

Equipment Leased

At present, BWIA leases one Boeing 707, bypass engine-powered transport, four Viscounts and two Bristol Britannia turboprop transports from BOAC to serve about 13,000 mi. of routes that extend throughout British and French West Indies and beyond to Central and South America, the U.S. and England.

Trinidad wants to operate BWIA as its national flag carrier. However British and U.S. aviation authorities have no doubt that the new government, with the multitude of problems any new government inherits, will be willing for any extensive length of time, to carry the burden of deficits the airline incurs annually to cover the carrier's indebtedness.

Friction has existed for some time between BOAC and BWIA and it is not considered likely that the British will be eager to underwrite the operation of BWIA. Meanwhile, Trinidad has invited Antigua, Barbados and Jamaica to participate financially in the operation of the airline.

The islands which are expected to form the West Indies Federation include four Windward Islands—St. Lucia, St. Vincent, Dominica, Grenada—and three Leeward Islands—Antigua, St. Kitts and Montserrat. Most islands in the West Indies group are served by BWIA and are linked by a feeder service conducted by Leeward Islands Air Services operating Beechcraft Bonanzas and de Havilland Herons.

It is extremely doubtful that the proposed federation, when and if it is formally proclaimed, will attempt to operate any government sponsored airline service. Instead, as in the case of Jamaica, it will seek an service from flag carriers of other nations.

Pan American's New York-Jamaica nonstop route is an outcome of a series of bilateral talks which began with the British in Barbados in the spring of 1960 (AW May 21, 1960, p. 25). U.S. also received Atlanta-Jamaica rights but the government has not yet designated a carrier to operate the route. Because of earlier plans for a federation the West Indies were invited to participate in the discussions.

Bargaining during the meetings was stiff and several U.S. delegates returned with the distinct impression that the British were able to reject most U.S. bids for new routes because the U.S. had to offer in trade few routes that the British wanted or needed. The prime U.S. objectives—an extension of North West's route from Tokyo to Hong Kong and Peking of Frankfurt and Zurich to close a gap on TWA's European route—were again shunted aside by the British (AW June 20, 1960, p. 88).

The nonstop route between Jamaica and New York, served also by BOAC and Avianca, was given in exchange for New York-Antigua nonstop authority. U.S. delegates were curious as to why the British sought this route, which will be inaugurated with Boeing 707s on a twice-weekly basis by BWIA on April 4, rather than a New York-Trinidad nonstop route. The feeling here is that the British view Antigua as a potential hub for all tourist travel in the Caribbean area. The little island has doubled its tourist facilities in the past few years.

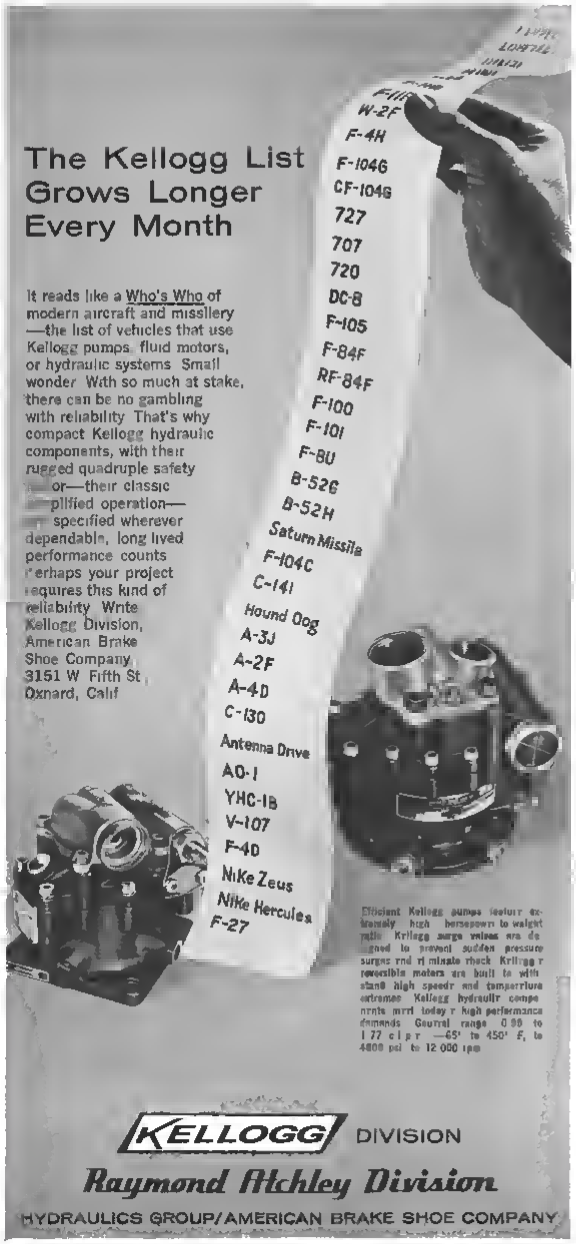
Independence and the formation of

Electra-Convair Exchange

Braniff Airways is acquiring a ninth Lockheed Electra, replacing an airplane lost in a crash at Buffalo, Tex., in 1959, in a transaction that will provide Allegheny Airlines with three Convair 440s and two Convair 340s plus spares from Braniff.

Lockheed acted as intermediary in the exchange since the Electra is one of five Lockheed built for Capital Airlines but which were not delivered when Capital merged with United Air Lines. Allegheny will take delivery on the Convairs to replace its Pratt-powered Convair 540s that are being withdrawn with the cancellation of the Eland engine program.

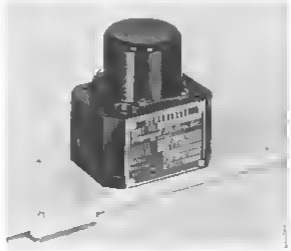
Of the other Electras, one was sold to Pacific Southwest Airlines to give the intrastate carrier a total of five, and the other three to Sports Aloft, a leasing organization.



Unique Atchley Servovalve Proves Answer to Fluid Contamination Problems

The Atchley *Jet-Pipe* servovalve has proved its ability to virtually eliminate contamination as a problem — or even as a factor. In doing so, the valve has made possible appreciably higher hydraulic system reliability.

When originally developed by the Raymond Atchley Division of the American Brake Shoe Company, this unique servovalve was subjected to five independent tests at unprecedented levels of contamination — 25 times greater, in fact, than ever before thought feasible. The test system actually failed because of the severity of the contaminants but the valve nevertheless demonstrated its ability to perform continuously and with complete reliability.



The Atchley servovalves can operate with contaminants as large as 200 microns without malfunction.

Atchley servovalves, with their exclusive *Jet-Pipe* feature, now play an important role in major airborne and space electrohydraulic systems. The Atchley valve provides positive automatic control without requiring costly, painstaking contamination-control measures.

Other Raymond Atchley products are servoamplifiers, torque motors, and complete servo systems for aerospace, ground support, and other military applications. In the design and development of complete systems, the Atchley Division cooperates with other members of American Brake Shoe Company's Hydraulics Group such as the Kellogg Division (manufacturers of pumps and other air- and space-borne hydraulic equipment). Also available for consultation are American Brake Shoe Company's Hydrodynamics Laboratory in Columbus, Ohio, and the corporate Research Center in Mahwah, New Jersey.

Raymond Atchley Division is at 2231 S. Barrington Avenue, Los Angeles 64, California.

the federation in the West Indies will automatically lift the cabotage restrictions which legally exist while the island group is a British colony. It is highly possible that the U.S. can negotiate with the new governments for further route and traffic grants throughout the area, which would open new doors for U.S. airlines.

This raises the question of how existing bilateral agreements between the U.S. and Great Britain will be treated with respect to the West Indies. Presumably, the agreement will be transferred to the new governments. Government officials here were not prepared to say whether the agreement would be allowed to remain in effect or would be renegotiated.

Since most of the rights won by the U.S. at the bargaining table represent a trade with the British on a quid pro quo basis, the U.S. has been somewhat restricted in the development of its routes. Now, however, because the new governments, with the possible exception of Trinidad which has its own flag carrier, may not seek reciprocal rights, the U.S. may be heir to more generous route grants in the future.

At present, only one island of the proposed federation—Antigua—is served by a U.S. airline. Pan American operates through Antigua on a route between San Juan and Trinidad with other intermediate stops at St. Croix, Guadalupe, Martinique and Barbados.

U.S. carriers with authority to serve the Caribbean and related areas—Braniff, Delta, Mackey, National, Pan American and Trans Caribbean—operate schedules over relatively restricted routes and in the face of high density competition. The small islands of Nassau and Barbados, for example, are served by six major international carriers.

Eastern is restricted to routes between Miami and San Juan and New York and San Juan without beyond rights to other Caribbean points. Its only foreign route in this sector is authority to serve Bermuda. National is confined to a Miami-Havana route in its Caribbean service. Mackay, on its short Florida-Nassau-Grand Bahama route, is competing with two foreign flag carriers.

Although its Caribbean routes are extensive by comparison, Pan American is competitively handicapped by several route restrictions. For example, Pan Am does not have the beyond rights authority on its New York-Nassau route that is held by BOAC and KLM.

A serious weakness in the competitive position of U.S. Caribbean carriers is the lack of authority to serve Europe from the Miami and Caribbean gateways. Both Britain and Mexico have routes across the South Atlantic to European ports of entry from Miami. In addition, other nations—notably France, Britain, Spain, The Netherlands and Italy—hold authority to serve the Western Hemisphere from Europe and South American gateways. The U.S. has made a bid to Spain for a Miami-San Juan-Madrid route, as well as a Madrid stop for Pan American on its New York-Africa route but Spain has stubbornly refused to discuss the request.

However, Aviation Week has learned that recently Spain indicated a willingness to discuss the southern transatlantic route, although they want to hold the Madrid question in abeyance. The U.S. government has not followed through on this opening since it prefers to discuss both issues as a package and is continuing to try to persuade Spain to negotiate the entire matter at one time.

Airline Carriers List Officers' 1961 Salaries, Bonuses, Expenses

Washington—Following is a list of airline officers' salaries, bonuses and indirect compensation, expenses and stock holdings for the year ending Dec. 31, 1961, as reported to the Civil Aeronautics Board:

National Airlines Inc—G. T. Baker, chairman of the board, $50,274 salary; $18,780 expenses; 165,932 shares of common stock; $150,000 debentures. J. C. Beaward, executive vice president and director, $28,137 salary; $1,915 expenses; 1,602 shares of common stock; $22,500 debentures. W. H. Caldwell, assistant treasurer, $13,450 salary, $1,383 expenses; 78 shares of common stock; $500 debentures. J. W. Calhoun, vice president, $14,901 salary. R. Drake, treasurer (term expired Apr. 7, 1961), $1,250 salary, $6 expenses. L. W. Dymond, vice president, $22,509 salary; $1,110 expenses; 669 shares of common stock. R. A. Fitzgerald, vice president, $14,801 salary; $303 salary; 104 shares of common stock. A. G. Hardy, senior vice president, $10,509 salary; $1,594 expenses. W. F. Johnston, vice president and treasurer, $16,892 salary; $1,905 expenses; 2,451 shares of common stock. J. L. Morris, vice president, $18,985 salary; $3,711 expenses; 3,964 shares of common stock. N. M. Pugsley, assistant corporate secretary, $6,250 salary. G. W. Paul, assistant vice president, $1,330 salary; $2,233 expenses. J. M. Rosenthal, senior vice president, $22,509 salary; $1,543 expenses; 2,022 shares of common stock; $1,200 debentures. C. F. Sharp, vice president, $9,382 salary; $2,487 expenses. A. L. Stanley, assistant vice president, $8,050 salary; $836 expenses; six shares of common stock. H. B. Taylor, secretary and assistant treasurer, $16,922 salary; $2,308 expenses. R. E. Wirland, president and director, $18,987 salary; $3,471 expenses; 5,087 shares of common stock. W. F. Pilgge, vice president, $13,500 salary; $2,641 expenses; 150 shares of common stock; J. W. Cress, director, 3,671 shares of common stock; $20,000 debentures. A. L. McCarthy, director, 1,595 shares of common stock; F. C. McDonald, director, $400 expenses; 216 shares of common stock; $100 debentures. A. G. McNeese, director, $750 expenses; 102 shares of common stock. S. F. B. Morse, director, $150 expenses, 100 shares of common stock; F. B. Stold, director, 180 shares of common stock. J. A. Waterman, director, $600 expenses, 862 shares of common stock; $2,000 debentures. D. K. Topping, director, $600 expenses; 1,056 shares of common stock. B. Winiarz, director, $150 expenses. G. W. Gibbs, director.

Following firms were paid $5,000 or more for services rendered during 1961: Alexander & Alexander, actuarial services, $9,190. Morrisbalk-Pratt, advertising services, $2,398,261. Cross, Murphy & Smith, legal services, $51,030. Denning & Wohlstetter, legal services, $6,300. Hunk Mayer, Associates, public relations, $42,022. Sidney S. Baron, public relations, $8,000. Scott, McCarthy, Preston, Steel & Gilbreed, legal services, $50,404. Wyatt, Gerhardt, Schulman & Manning, legal services, $9,675. Ernst & Ernst, managerial consultants, $5,327. Public Relations Aids, Inc., public relations, $8,400. Hankins & Sells, auditing, $13,400.

Alaska Coastal Airlines—S. B. Simmons, co-manager, $19,152 salary, $1,268 expenses. O. F. Benrike, co-manager, $20,782 salary, $2,249 expenses.

Following firms were paid $5,000 or more for services rendered during 1961: Theodore I. Seaman, legal services, $12,489. Rubenstein, Monagle, Fuhrman & Annis, legal services, $6,215.

Wien Alaska Airlines, Inc.—S. Wien, president and chairman of the board, $23,000 salary, $184 expenses, 5,560 shares of common stock. G. R. Rayhoen, executive vice president, $20,124 salary, $1,203 expenses, 1,102 shares of common stock. F. Wien, vice president operations, $18,550 salary, $534 expenses, 1,105 shares of common stock. A. F. Bugbee, vice president-traffic, $18,975 salary, $3,731 expenses, 164 shares of common stock. N. Wien, vice president-public relations, $18,975 salary, $1,551 expenses, 1,164 shares of common stock. R. M. King, secretary, $20,010 salary, $656 expenses, 101 shares of common stock. M. Barnes, assistant secretary, $1,936 salary. M. Whitney, assistant secretary, 25 shares of common stock. B. Siebrit, assistant secretary. C. J. Chaby, director, 104 shares of common stock. A. Peiri, assistant secretary and director, 184 shares of common stock. B. Wien, director.

Following firms were paid $5,000 or more for services rendered during 1961: T. I. Seaman, legal services, $12,479. R. T. Lamson, aviation consultant, $6,033. Price Waterhouse & Co., income tax and auditing services, $7,206.

South Pacific Air Lines—R. S. Doller, chairman of the board, $4,504 expenses. R. C. Hencock, director, 25 shares of common stock. J. H. Dollar, Jr., president and director, $8,054 expenses. W. Strenberg, director (resigned Aug. 23, 1961), $10,100 bonus and indirect compensation, $2,088 expenses. R. H. Andreson, director, $46 expenses. J. G. Mitchell, director (died Oct. 22, 1961), $315 expenses. J. D. Hopkins, vice president, $237 expenses. W. F. Warren, vice president, $2,400 salary, $2,273 expenses. S. L. Wilson, vice president, $21,398 salary, $2,238 expenses. J. D. Penn, vice president (resigned Aug. 23, 1961), $16,500 salary, $4,291 expenses. M. McDonald, vice president, $10,833 salary, $3,512 expenses. G. A. Harrison, Jr., treasurer, $9,857 expenses. R. P. Seeley, secretary, $19 expenses. D. C. Nichols, assistant secretary-treasurer, $7,092 salary, $192 expenses. C. L. Fullerton, assistant treasurer. M. D. Vori, assistant secretary (resigned Oct. 31, 1961).

The following firms were paid $5,000 or more for services rendered during 1961: Bowne & Rosenthrgrr, legal services, $60,887. S. S. Culler & Associates, consultant, $6,231. Fuller & Smith & Ross, Inc., advertising, $5,462. Muller Sternberg, consultant, $7,278. Tyndall Associates, Inc., public relations, $8,337.

Avalon Air Transport, Inc.—Reports no officers were paid $20,000 or more and no firms were paid $5,000 or more during 1961.

AIRLINE OBSERVER

►Domestic trunklines reported revenue passenger miles increased again in February over the same month last year, but the percentage increase was inflated by the fact that operations of five trunklines were suspended during a part of February 1961, because of strikes. The 41% increase in available seat miles reported for February is also unrealistic for the same reason. Best indication of the industry's showing during the month is the overall load factor, which dropped 1.6% from January's level to an uncomfortably low 52.71%.

►Watch for a series of strikes at London Airport this summer by engineering and maintenance personnel. Unions representing 12,000 employes were turned down on wage demands by British Overseas Airways Corp., British European Airways and independent airlines on ground that the industry could not afford a pay hike in the near future.

►Issuance of a Commerce Department study on transportation, together with proposed White House legislation designed to strengthen U.S. transportation systems, already delayed a year, was postponed again last week. Chief reason for the delays appears to be discord over proposals for high-speed urban transportation systems. The report will touch only lightly on civil air transportation, since most airline issues were included in the Project Horizon report.

►Reason behind TWA's reluctance to relinquish its Caravelle 10A order, even though eventual cancellation is virtually assured (AW Mar. 19, p. 41), is the extremely favorable terms offered by Sud. If the 20 airplanes failed to make money on TWA's routes, Sud agreed to take them back, much as though they had been out on a lease basis. General Electric, which would supply the CJ805-23C engines, did not go along with this guarantee, but Sud indicated a willingness to accept responsibility for the engines, too.

►Douglas is estimating 120 orders as minimum for putting its model 2086 twin-jet short-haul transport into production. The airplane is now being referred to as the DC-9 in Douglas presentations.

►American Airlines' self-insured aircraft damage losses from 1957 through Mar. 10 this year totaled $10.4 million. This included the loss of two Boeing 707s in training crashes, and two aircraft—a 707 and a Lockheed Electra—lost in scheduled service. Eastern Air Lines also is a partial self-insurer and has reported losses of $371,000 from 1957 through 1961—a period that included the crash of an Electra at Boston.

►Aeroflot chief Yevgeny Loginov has retreated from the prediction of his first deputy chief that the Russian carrier will handle 30 million passengers in 1962 (AW Jan. 15, p. 44). Loginov now forecasts about 28 million passengers this year, a 31% increase over 1961. Loginov also predicted that in 1962 ton-mile costs will be reduced 10% and 68% of all passengers will be carried on turbojet or turboprop equipment, compared with 60% last year.

►United Air Lines is using a mobile electrical generating system tester to check out Douglas DC-8 generator control systems after overhaul. Main purpose of the tester, built by Textron, Inc., is to check DC-8 system protective functions. Carrier has also modified the DC-8's hydraulic system to enable flight crews to replenish supply of hydraulic fluid in flight.

►Maintenance inspection periods for Russian Al-20 4,000-hp. turboprop engines which power the Il-18 transport have not increased noticeably since introduction of the engine several years ago. East German Lufthansa reports periodic inspection of the engines after 20, 50 and 100 flight hr.

►Western Air Lines and Japan Air Lines have been negotiating for the sale of three of Western's 15 Douglas DC-6Bs to the Japanese carrier. JAL wants the pressurized aircraft to replace DC-4s on such routes as Tokyo-Osaka and Tokyo-Soporo.

SHORTLINES

►**Airport Operators Council** representatives have met with various national, state and civic groups to discuss the possible effects of the U.S. Supreme Court's recent decision that airport operators are responsible for damages caused by low-flying aircraft (AW Mar. 12, p. 319). A council spokesman indicated that Allegheny County, Pa., may file for a rehearing, which when disposed of by the court will make it possible to judge the effects better.

►**Air Transport Assn.** reports U.S. trunklines flew 2.33 billion revenue passenger miles in February and a total of 4.94 billion for January and February—an increase of 29.1% and 19% respectively over the same periods last year. Coach service accounted for 62% of revenue passenger miles last month compared with 51.6% in February, 1961.

►**Alitalia's** application for a route extension into Chicago (AW Feb. 26, p. 50) has received Civil Aeronautics Board and presidential approval. Service will begin Apr. 5.

►**Braniff Airways** has asked CAB to approve group fares, with reductions up to 25%, for travel between Braniff's U.S. points and Mexico City. Fares would be in effect between Apr. 6 and June 30, and between Sept. 1 and Nov. 30, for groups of 25 to 64 persons.

►**Delta Air Lines** reports it carried 1.84 million ton-miles of cargo last month—a 47% increase over February, 1961.

►**Flying Tiger Line** has filed a new simplified tariff with CAB to become effective May 1 if CAB approves. Earlier this month Flying Tiger filed to drop its complicated class rate tariff, as predicted by AVIATION WEEK (AW Feb. 12, p. 52), in favor of commodity groups identified by general terms such as "aircraft parts" or "automobile parts." Each general group would have a specific rate, many of which would reflect lower rates as offered by the old class rate formula.

►**Hawaiian Airlines** reports a net profit of $158,350 for 1961, compared with a $105,405 loss for 1960.

►**Trans World Airlines** plans to inaugurate a "thrift-nr" tariff between St. Louis, Miami and Tampa Apr. 14, subject to CAB approval. One-way fares will be St. Louis-Miami $47 compared with present $58.50 coach fare, St. Louis-Tampa, $41 compared with the present $47.60.

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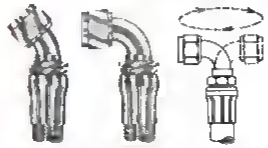
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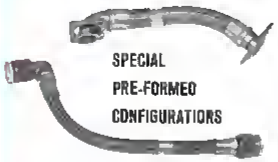




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Russian-built An-12 turboprop powered transport for Ghana Airways was photographed at London's Gatwick Airport en route to Africa

Rear-Loading An-12 Has Glassed-In Nose and Tail

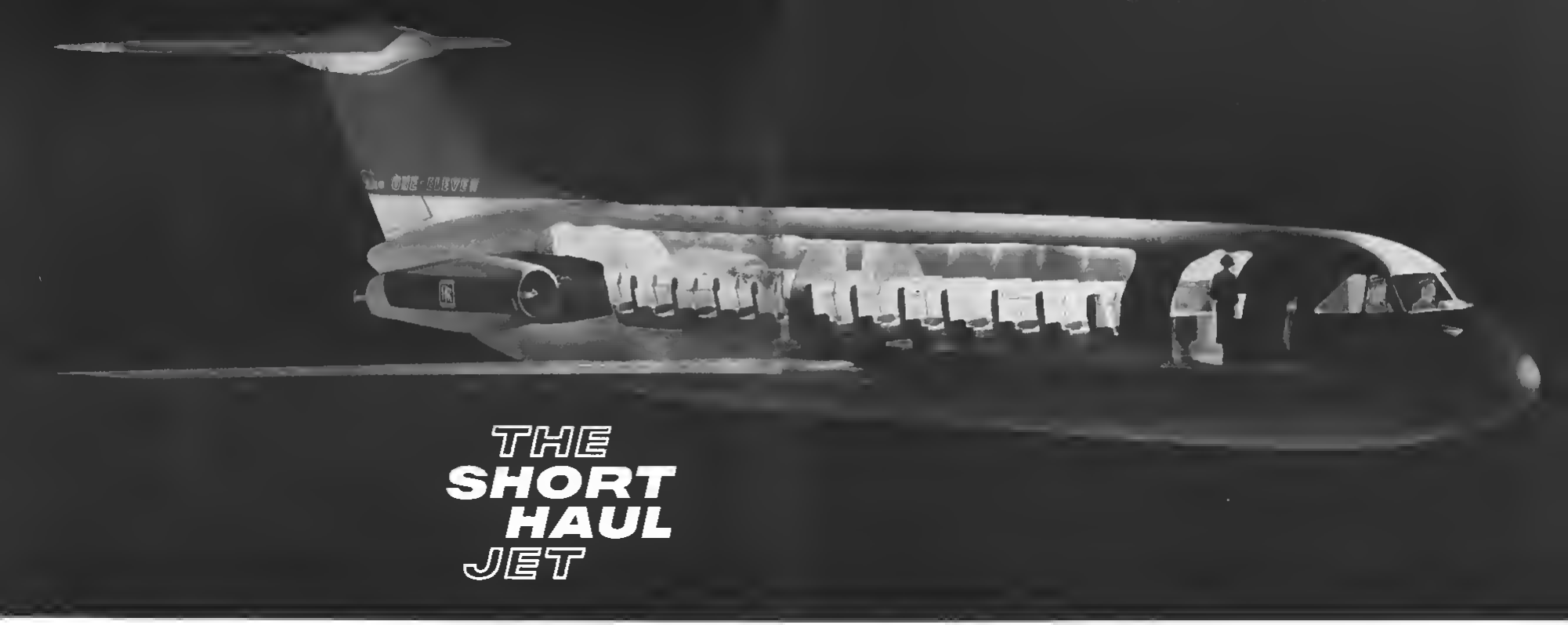




Armament has been removed from the tail-gunner's compartment of the An-12, above left, and the area has been converted to a toilet. Stubby, cigar shape of the fuselage and landing gear arrangement are shown, above right along with rear door. Below left glassed-in nose and weather radar bulge are shown. Nose appears to have flat angled section which could be used for optical equipment. Right outboard engine nacelle is slender and has close fitting cowling behind a large spinner. The aircraft is powered by Ivchenko AI-20 turboprop engines. Note de-icing equipment on propeller blades and antenna wires strung from vertical fin







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U.S. Begins Laser Weapons Programs

By Barry Miller

United States is launching a number of optical maser lethal-weapons programs which may lead to entire families of revolutionary new weapons possibly including a fast, "clean," non-nuclear defense against ballistic missiles, by as early as the middle of this decade. These weapons would use the extremely high-energy beams of electromagnetic radiation generated by optical masers (lasers), an obvious projection of the 'death ray' weapons of science fiction.

Office of Naval Research currently is evaluating industry proposals, preparatory to selecting 10 contractors to conduct 45-day feasibility studies of optical maser radiation weapons. Later, two of these contractors will be asked to continue their efforts toward the development of high-energy radiation weapons. These efforts are expected to produce workable surface-to-air weapons several years hence.

Dozens of companies are believed to have bid on the $2.5 million ONR program funded by the Advanced Research Projects Agency. Representatives of more than 70 aerospace organizations attended an ONR bidders briefing held last month in Washington at the Department of Interior auditorium.

Bidders probably include: Radio Corp. of America, General Electric, American Optical, Raytheon, Hughes Aircraft, Electro-Optical Systems, Chrysler, Quantatron, General Mottors, Technical Research Group, Sperry Rand, Westinghouse, Texas Instruments, Martin Co., Litton Industries, General Precision Laboratories and Philco.

Practicality of radiation weapons using infrared, visual or ultraviolet light is yet far from certain. The outputs in power, total energy and power or energy density of present optical masers in most cases fall below necessary levels for weapons use. But through surprisingly rapid device advances in recent months, outputs have risen by orders of magnitude to attractive levels and devices with promising properties seem within reach.

Other problems, such the need to be able to concentrate enough energy at a distant spot in space to melt an incoming ballistic warhead, remain.

In apparent hopeful expectation, the Air Force, Army and Navy, with Department of Defense knowledge, today are flooding industry with requests to bid on programs directly associated with optical maser radiation weapon studies and developments or R&D efforts on optical components essential to radiation weapons. Much of current government interest in optical masers is motivated by interest in weapons and a substantial portion of newly funded R&D is oriented, or being reoriented in directions which will lead to or support radiation weapons developments. Typical of the latter is an Air Force Aeronautical Systems Division $1-million program on laser materials, crystals, pump sources and device configurations (AW Feb. 12, p. 32) which has heavy radiation weapons overtones.

Studies Awarded

A number of radiation weapons studies have already been awarded to industry. American Optical Co., Southbridge, Mass., recently received a contract for a high energy radiation device from the Army Ordnance Missile Command, Huntsville, Ala., the agency through which terminal ballistic missile defense systems such as Nike Zeus and Arpat are funded.

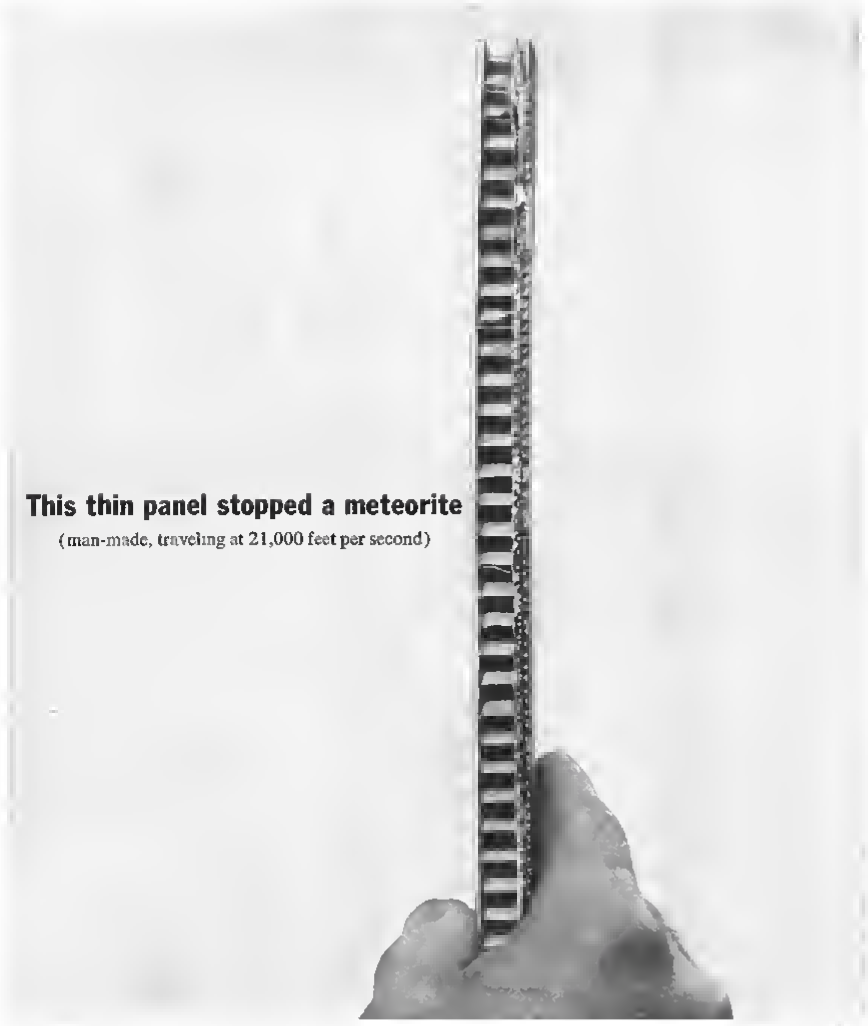
American Optical's contract is reported to be one of several in an AOMC Rocket and Guided Missile Agency program to look into present and long-range future of radiation weapons based on optical radiation. An earlier ARGMA contract with Westinghouse, involving a study of a weapon using ultraviolet radiation generated by incoherent rather than maser sources, is continuing, according to a company representative. In what is believed to be another award in this weapons series, Quantatron Inc., Santa Monica, Calif., will conduct R&D on an ultraviolet optical maser for AOMC.

Indications are that by the years end as many as two dozen organizations active in optical maser work may be brought under government contract for radiation weapon studies.

For the Army program, American Optical is expected to investigate the possibilities of securing high energy outputs from an optical maser which uses a rare earth element. Neodymium, in



GLASS OPTICAL MASER of the type that is attracting Army and Navy interest for possible use in radiation weapons because of promise it holds for extremely high power outputs is shown being operated by Dr. Elias Snitzer, chief physicist for American Optical Co. Device radiates coherent infrared energy at 1.06 microns. Company recently received Army Ordnance Missile Command contract to develop high-intensity radiation device in connection with Army optical radiation weapon program. Future optical masers in the form of glass fibers, as suggested by American Optical, may ease the task of removing heat generated by high power optical masers, an important problem in radiation weapon design.



This thin panel stopped a meteorite

(man-made, traveling at 21,000 feet per second)

A steel pellet struck this panel at 21,000 feet per second – more than six times the speed of a high powered rifle bullet – but could not pierce it. It disintegrated after puncturing the outer metal skin, and dissipated all its energy without reaching the inner lining.

This composite honeycomb panel is one of the techniques Northrop is developing to protect spacecraft against meteorite collisions. The entire lightweight panel is less than half an inch thick, and the honeycomb is filled with sealant to prevent air from escaping in case a particle should ever penetrate.

Though most of the meteorites a spacecraft is likely to encounter will be fine as dust, some may be as large as buckshot, and dense enough to puncture an ordinary metal skin. The search for materials to meet this hazard is another example of Northrop's practical work on the problems of space.

NORTHROP

glass as the active medium, a device reported by this company months ago. Since the Neodymium-glass material is non-crystalline, unlike other solid media known to have operated as optical masers, its size, and consequently its output power which is a direct function of size, can be increased sharply. This possibility accounts for tri-service interest in the device.

The ONR program may focus on both Neodymium in glass and ruby optical masers. Ruby devices are of apparent immediate interest because so much of industry's research and development has centered on them. Consequently more is probably known about it than any other type of optical maser. Ruby devices have been modulated successfully by several techniques. Highest known peak power levels and pulse repetition rates have been attained with ruby and rather good quality ruby crystals are now being grown.

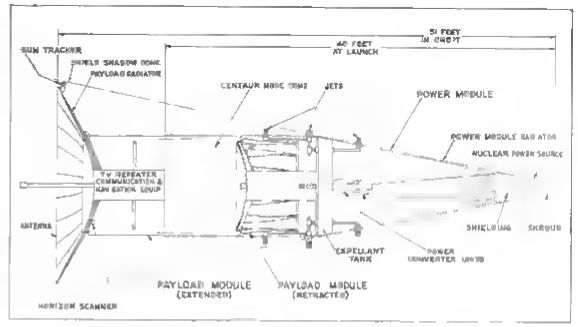
Anti-ICBM Advantages

As a defense against ballistic missiles, an optical maser radiation weapon may have several attractive advantages over other terminal defense techniques. These include:

• **"Clean" weapon**—The kill mechanism of a radiation weapon is the high energy density or power density (in power per solid angle) which today is sufficient to vaporize refractory metals at short distances. Hence, in a projected long-range defense system, there would be no need for a nuclear warhead such as Nike Zeus might require, eliminating dangerous nuclear fallout over friendly areas.

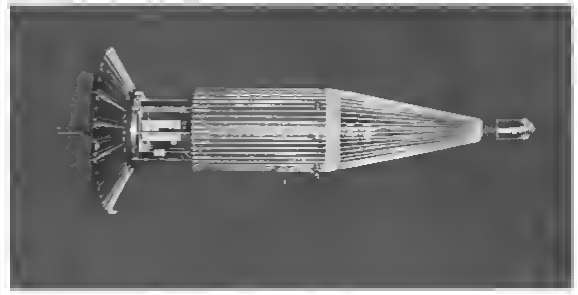
• **Time**—All electromagnetic rays, be they radio, visible, infrared or ultraviolet light, travel at the speed of 186,000 mps., orders of magnitude faster than even a high thrust-to-weight ratio Nike Zeus missile, thus giving a defense far more detection, tracking and, if need be, discrimination time. A defense would not have to predict future warhead intercept positions as the delay from firing a pulse to reaching a target would be less than milliseconds. It would not be necessary to calculate guidance commands as it would be for a Nike Zeus. Saturation of a defense by missiles and decoys would not be the problem it is for Nike Zeus.

• **Large volume coverage**—Although the beam of an optical maser is narrow it broadens with distance, and since many optical lasers probably will have to be arrayed together and their beams made parallel for an effective ground-based anti-missile system, a large conical volume will be covered. The combination of large volume, plus the rapidity with which the beam can be pulsed and switched and the short delay, may solve by brute force the decoy discrimination problem—burning up or neutralizing warheads and decoys alike.



RCA Proposes Nuclear-Powered Comsat

Nuclear-powered communications satellite, proposed by Radio Corp. of America, would have payload retracted into body above nose cone of Centaur launch vehicle. After separation, payload, including TV repeater, communication and navigation equipment would extend and furled antenna would unfold. Sun tracker and expellant jets would keep the nuclear-powered communications satellite properly oriented.

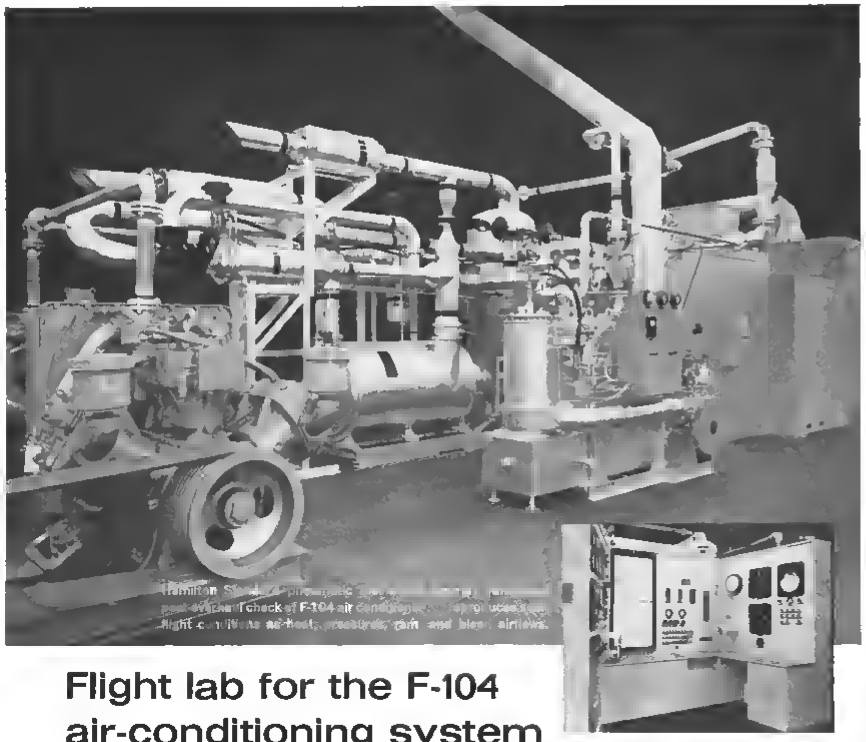


The idea of using the optical maser as a source for a radiation weapon or death ray arose before the first device was operated (AW Dec. 14, 1959, p. 87) and has been the subject of widespread speculation for three years. Government and industry interest mushroomed (AW May 1, p. 23) with device advances and was reflected in published replies to an electronic research technology survey, conducted by Department of Defense's Director of Defense Research and Engineering (AW Oct. 23, p. 51). In that survey one of several similar replies stated: "The ability of the optical maser (laser) to transform broadband energy into the energy of a single optical line makes it possible to concentrate the emergent coherent light to a fine focus and to achieve effective communication, point-to-point power transmission, or by concentration of an adequate amount of energy, even the destruction of enemy missiles at relatively long range."

While the earth's cloud cover offers anything but an optimum medium for optical and infrared energy, it is likely that with the extremely high energy expected to be concentrated in a weapon beam, efforts will be made by straightforward brute force to burn the beam through cloud cover. Obviously, this will be a less formidable task at wavelengths having good transmissibility through water vapor.

The problem then would be to find optical maser materials which can radiate high powers in the so-called window wavelengths.

Current optical maser weapon programs are not the first U.S. efforts to investigate the feasibility of radiation weapons. Under the several-year old GUIDAR (Guide Lines for Investigations, Planning and Research) program, various types of electromagnetic radiation weapons—microwave and infrared—as well as other exotic anti-ICBM techniques like ball lightning (AW Dec. 4, p. 52) were investigated. However, the optical maser, with high level peak



Flight lab for the F-104 air-conditioning system

The Lockheed F-104 Starfighter's air-conditioning and pressurization system "flies" within this pneumatic test stand, designed and built by Hamilton Standard.

Two electrically driven 150-hp reciprocating compressors in the test stand simulate engine bleed air. This air, routed through aftercooler-water separator, surge tank, and furnace, is then supplied to the turbine fan and the test chamber. A 150-hp turbine compressor simulates ram air. Capacity: bleed air, 55 lbs/min at 200 psig, 480°F; ram air, 130 lbs/min at 6 psig, 400°F; pressure, up to 1 lb/min at 550 psig.

Building test stands of this type demands a high degree of technical competence in systems engineering, electrical circuitry, pneumatics, hydraulics, electronics, and packaging. At Hamilton Standard, these capabilities are integrated with quality manufacturing.

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pulse power already available, starts out as a more promising technique than the others appeared at the conclusion of the GLIPAR studies. Microwave, for example, labors under serious limitations in this respect, including the difficulty of focusing its energy to a point in space.

Beam Focus

The output beams of optical masers can be focused by optical means to points in space over long distances, a basic prerequisite for a defense weapon. The remaining problem is to see how well large quantities of energy can be concentrated by paralleling outputs of optical maser arrays.

An early effort to investigate a phased array of optical masers for weapons applications will be initiated soon by USAF's Aeronautical Systems Division in a $ 5-million program.

The array problem will be crucial in optical maser radiation weapons as the ability to add large numbers of these beams and properly synchronize their pumping sources may be the key to successful radiation weapons. One of the first proposal requests in this field, in this case for radiation weapons optics, originated with Rome Air Development Center (AW Oct. 23, p. 19), the source of most Air Force work in phased array techniques.

Weapons work like other applications for optical masers, will require, besides extensive materials investigations, component development leading to useful phase shifters, isolaters, rotators, etc., which would be useful both for weapon systems and other applications.

Much attention will have to center on pump sources to make them more efficient and reduce power requirements. Several requests for weapon pump sources circulated through industry recently.

The optical maser radiation weapon will have far broader implications than ballistic missile defense alone, although the latter is the prime need. In space, beyond the attenuating and scattering effects of the earth's atmosphere, power requirements might be sharply reduced, and with device refinements, weapon devices made small enough to be carried on inspector satellites or larger space vehicles as anti-satellite or spacecraft defense weapons.

As an anti-personnel or anti-tank weapon the device would be useful, but, some industry sources speculate, is roughly like shooting pheasants with an elephant gun. Nevertheless, these applications are being investigated by Army agencies such as Frankfort Arsenal. Setting up a defensive curtain through which neither man nor machine could pass may also be a distinct radiation weapon possibility.



GIANNINI CONTROLS CORPORATION

LOOKING FORWARD

by Julian Hertt

DUARTE, CALIFORNIA — World attention soon will focus again on Kwajalein Atoll in the Marshall Islands.

Anyone familiar with Kwajalein, ten feet above sea level at best, wonders wryly why this coral necklace has not long since slipped back into the Pacific.

The U.S. Navy and Marine Corps slammed tons of steel into it in 1944. The atoll later knew the violence of nuclear testing.

Today, Kwajalein teeters again under the weight of jam-packed equipment and people as the U.S. Army nears a climactic milestone in development of Nike Zeus, the anti-ICBM missile.

On the chosen day, a Zeus will flash up to intercept a target "warhead" launched by an Atlas ICBM from California less than 30 minutes before.

The critical question: Will the "miss distance" of the Zeus-Atlas intercept, at closing speeds up to 20,000 miles per hour, be within lethal range of the nuclear warhead to be carried by an operational Zeus?

The Army is confident Zeus will succeed. But none realizes better than the Army's Zeus people how much rides on the unfaltering performance of the Target Scoring System in reporting 'pudding proof' of such a success.

Major General August Schomburg, boss of the Army Ordnance Missile Command, recently told this writer the Army wants to know "exactly how close' Zeus is to target, the scoring system must be "completely honest."

That is a tremendously difficult assignment in the harsh reentry environment where Zeus meets Atlas.

Many have addressed themselves to problems of measurement and communications in that area. These efforts range up the spectrum from VHF through UHF and microwave frequencies, into infrared and optical.

Here in the Systems Division of Giannini Controls, target scoring was attacked farther up the spectral ladder, based on radioisotope propagation and detection in the X-ray and gamma ray region.

The work already has resulted in GCC's Photon Target Scoring System, using Tantalum 182 as the source of high energy gamma rays, which has been highly successful in initial tests for Sidewinder and Sparrow air-to-air missile applications.

But the technique is particularly suited for the anti-ICBM ranges, since the gamma particles suffer only negligible interference from the ionized shock waves enveloping reentry bodies.

Donald E. Wright, Manager of Advanced Systems in CCC's Systems Division, is a key figure in radioisotope developments. Calgary-born, Don, whose M.S. in Nuclear Engineering earned at the University of Washington four years ago was the first of its kind, says:

"It's pretty straightforward. When you have to make a measurement inside a vehicle, of a parameter that's outside the shock wave, you're forced to start talking about radioisotopes. You can't cut holes because of the ablation blanket. You can't add probes that create their own shock waves."

He adds radioisotope systems also are most attractive because their light weight imposes no major penalties on payloads, their small size and intrinsic characteristics allow them to be tucked inside any vehicle without compromising external design, and their reliability is virtually as predictable as radioactivity itself.

The Photon Target Scoring System, developed as a back up for the Zeus tests, has opened up a broad spectrum of future radioisotope applications. These range from safer landings of big jets on earth and safer spacecraft landings on the moon, through low altitude altimeters, to real time measurement of ambient density, hence altitude, for pilots of Dynasoar and Apollo type craft during the critical reentry regime.

Wright's enthusiasm for present and contemplated applications — Much measurement, pitch-yaw detection, distance measurement in delicate Gemini-type space docking maneuvers, altimeters for Apollo moon landings or to give pilots real time wheels-to runway measurement in inches — is shared by the whole CCC team.

From measuring thickness of cigaret paper less than a decade ago, radioisotopes have come a long way. It is only the start of a broader highway ahead for those ... Looking Forward.

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KEEP YOUR EYE ON



NEW TYPE KLYSTRON TUBE, developed by General Electric, may provide 10- to 100-fold increase in microwave power that can be generated through use of multiple electron beams Prototype model shown at left using 10 beams generates 32 kilowatts at X-band under continuous operation Outputs of one megawatt at X band appear possible Sketch (right) shows periodic wavelength type cavity used to phase-lock each of the beams so that injected radio frequency signal can extract power from each of the beams.

GE Discloses New Type Superpower Tube

By Philip J. Klass

New type klystron tube using multiple electron beams which shows promise of a 10- to 100-fold increase in generated power compared with a conventional single-beam klystron has been successfully demonstrated by General Electric's Power Tube Department in Schenectady, N Y

The company has built several tubes with 10 electron beams that have delivered 32 kw of continuous-wave (CW) power at X-band under sustained operation A 100-kw tube is under design and GE studies indicate that tubes with outputs of a megawatt at X-band are feasible, with higher outputs at lower frequencies The multiple-beam klystron can be designed for either CW or pulsed-type operation

First details on early experiments with the new type klystron will be reported this week by GE scientists at the Institute of Radio Engineers convention in New York Initial work was sponsored by the Advanced Research Projects Agency and is being monitored by the Army Signal Corps

In the new multiple-beam klystron the power of many electron beams is combined within a single tube structure rather than paralleling the outputs from several conventional single-beam klystrons GE claims the new technique offers a number of significant advantages and attractive trade-off opportunities for radar system designers These include

• **Lower operating voltage.** Compared with a single-beam klystron of the same power output, the new type tube can operate with an anode voltage which is one-third or less that of the conventional tube

• **Reduced harmonics.** The multiple-beam klystron has inherent harmonic reduction properties In one GE test the third harmonic of a 10-beam experimental klystron was 51 db below the fundamental approximately 6 db less than an equivalent single beam tube, a company spokesman said

• **Improved reliability.** For the same output, a multiple-beam tube would operate at lower current densities than a conventional tube and thus, GE predicts should result in longer life and better reliability Failure of one or several electron beams in the new type tube would reduce power output proportionately, but will not produce mismatch problems that occur when several conventional klystrons are being operated in parallel and one or more of the tubes fails, GE says

• **Lower cost.** GE studies suggest that the multiple-beam klystron can generate microwave power at lower cost per watt than conventional tubes Cost of fabrication is expected to be less than equivalent single-beam tubes with associated control equipment based on present manufacturing experience

• **Smaller size, less weight.** Because of lower operating voltage the new type klystron is expected to be smaller and lighter than a conventional klystron with equivalent output, GE says Modulator design will be simplified and X-ray radiation problems reduced, GE says The external accessories such as power combiners, phase control devices and dummy loads now required to parallel the output of several conventional klystrons also are eliminated

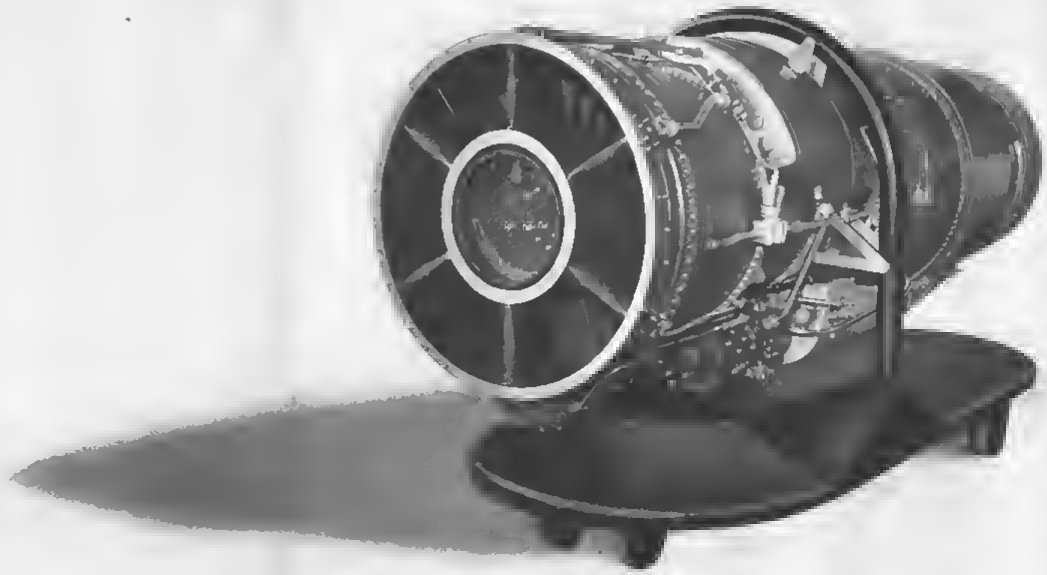
The 10-beam, 32-kw development models which GE has built and tested operate at an efficiency of about 32%, with a gain of 46 db at an anode voltage of 12 kilovolts Bandwidth is about 1%, but calculations indicate that this can be increased to about 4% a company spokesman said A tube designed for pulsed operation should exhibit an efficiency of approximately 40-45% he added

In the new type klystron, the single input cavity of a conventional tube is replaced with a periodic type wave guide circuit (see photo and sketch) The geometry and dimensions of this periodic waveguide cavity are such that a low-level microwave signal fed in at one end results in a voltage maximum at each of the multiple electron beams located along the length of the cavity

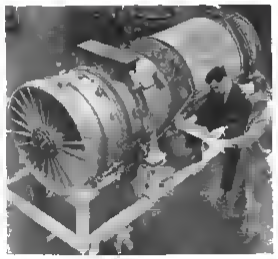
The RF field thus produced reacts with each of the electron beams, enabling each beam to deliver energy to the resonator field In this respect the operation resembles the operation of a series of separate single-beam klystrons except that the individual interactions all are phase-locked because the RF fields are tightly coupled through out the resonator

Three or more such extended periodic waveguide cavities are employed in the GE tube, similar to the multiple cavities used in a conventional klystron to achieve increased efficiency and gain The sum of the power contributed by each of the multiple electron beams is combined in an extended output cavity and directed to one or more waveguide output windows

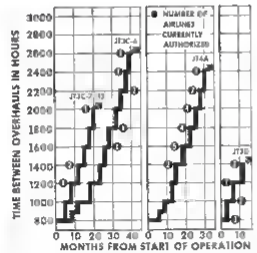
The periodic cavity structure which GE employs is essentially a strip of



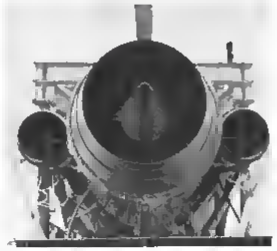
This one was so reliable we've built 23,000 more



Rugged steel and titanium construction helps engines minimize foreign object damage. Durable, lightweight titanium is a feature of Pratt & Whitney Aircraft designs.



Reliable engines help reduce maintenance costs. Pratt & Whitney Aircraft commercial turbojet engines have achieved an outstanding time-between-overhaul record.



Extended endurance run is one of many tests to improve engine durability. Pratt & Whitney Aircraft designs have consistently met or exceeded performance guarantees.

When Pratt & Whitney Aircraft's first J57 jet engine entered service in 1953, it was designed to be simple, reliable, rugged, and capable of significant performance growth.

More than 23,000 engines later, Pratt & Whitney Aircraft still stresses the same engine qualities. Take reliability. Some of today's JT3's (commercial J57's) are authorized 2,600 hours time between overhaul. The more powerful JT4, using the same proven design, reached 2,400 hours time between overhaul in only 30 months. With this dependability, and simple maintenance, parts replacement costs per engine flight hour are the lowest in the industry.

Pratt & Whitney Aircraft

UA

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Pratt & Whitney Aircraft jet engines have also shown important advances in performance. Thrust has grown from 10,500 pounds in early turbojets to more than 18,000 pounds in the newest turbofans. Other significant developments—like more durable and more efficient parts—have continually helped to reduce weight, improve fuel consumption, and increase dependability.

By making good engines better, Pratt & Whitney Aircraft helps airlines operate their jets more economically. This reliability is another reason why Pratt & Whitney Aircraft jet engines fly more people more places than any other engines in the world.

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PROGRESS IN ELECTROLYTIC CAPACITORS



NOW...

450-volt ratings in foil capacitors

Save space and weight with new General Electric 375- and 450-volt single-cell, foil Tantalytic* units

Now, you can save up to two-thirds the space and 85 percent of the weight of capacitors presently used in high-voltage circuits with **one** G-E foil capacitor in the **new** 375- or 450-volt ratings.

New 450-volt units are available in five case sizes, of polar design, with capacitance values from 0.15 to 6 microfarads. They are presently rated —55 C to 85 C. The 375-volt units are also rated —55 C to 85 C, and are available in seven case sizes, in values from 0.2 to 17 microfarads.

In these new capacitors, as in the full line of high-voltage units from 200 volts up, General Electric's experience in building **foil** Tantalytic capacitors assures unmatched reliability and performance. With the 450-volt units, for example, you get a close tolerance of ±15 percent. And, after 2,000 hours, capacitance is at least 90 percent of rated value.

Data on G-E high-voltage foil capacitors, including the new 375- and 450-volt units, is found in Bulletin GET-2977. Ask your G-E Sales Engineer for a copy today. Or, write to Section 430-10, General Electric Co., Schenectady, N. Y.

Capacitor Department, Irmo, South Carolina

* Reg. Trade-mark of General Electric Co.

GENERAL ELECTRIC

waveguide which is periodically loaded with capacitors designed to operate in the $\pi/2$ mode. This mode was selected because there is maximum frequency separation between adjacent modes and all voltage maximums at each of the electron beams are of equal magnitude.

Tuning and coupling to such a multi-mode resonator are somewhat more complicated than in a single mode resonator, according to GE's R. A. Dahn. Loading the $\pi/2$ mode of the multi-beam klystron resonator to achieve the same "Q" as a conventional tube, requires that the load be coupled to the resonator with an increased tightness proportional to the number of electron beams used. Using an iris type coupling, GE says it can achieve any desired degree of loading. Mechanical tuning of the resonator can be achieved by varying the cavity dimensions in the same way as with a conventional tube.

End wall tuning is restricted to narrow frequency ranges to prevent distortion of the desired mode pattern. For wider tuning ranges, side-wall tuning is used.

In the report which Dahn will deliver at the IRE convention, he will state that the ultimate limits of power capability for the multiple-beam klystron are not precisely known. The first limitation may result from adjacent mode interference, which will depend upon circuit design, individual beam impedance and the ability to control mode excitation in the input circuit by selective loading or strapping. The best present estimate for typical existing klystrons is that this limitation will occur somewhere between a 40 and 100 electron beam configuration, according to Dahn.

Any new techniques developed to improve the performance of single-beam klystrons generally can be used in the multiple-beam version, with corresponding gains in its performance. The new technique is applicable to any shape of electron beam: cylindrical, sheet or hollow, GE says.

FILTER CENTER

►**Global Tracking Network**—Global tracking network known as GloTrack will be built for Air Force's Patrick AFB in connection with the Advent satellite program by General Dynamics/Astronautics to complement existing Atlantic Missile Range facilities. Network includes range rate measuring systems.

►**Advanced Molectronics Effort Planned**—Applied research investigation aimed at long-range molecular electronics requirements, with emphasis on novel techniques, materials, material combinations and block designs, is planned by USAF's Aeronautical Systems Division, Wright-Patterson AFB. Industry requests for bid sets must be made by Mar. 26.

►**Large Laser Crystals**—Quantatron, Inc., Santa Monica, Calif., has announced its scientists have succeeded in growing crystals of manganese-doped sapphire which are expected to be suitable for high efficiency, high-energy output continuous wave optical masers. Devices using these crystals would emit visible orange light beams (6,603 angstroms).

►**Auto Track/Scan Radar**—Long range, high-speed radar technique capable of simultaneously and automatically tracking and scanning has been developed by Sperry Gyroscope Co. and is being proposed to Air Force in current Rome Air Development Center/Electronic Systems Division competition for SPADATS (Space Detection and Tracking System). The radar uses phased array principles, reportedly an outgrowth of company's Athesa concept (AW Aug. 21, p. 54). A multi-element array of this type has been built, installed and is operating on the roof of a company plant in Great Neck, N. Y.

►**Effects of High-Intensity Light Beams**—Skin of a pig will be subjected to high-intensity beams in a study funded through a $75,000 Air Force contract awarded New York University and Technical Research Group, Inc. The two organizations previously have studied radiation effects on rabbit eyes as part of continuing study to determine the effects of extremely high intensity beams from optical masers.

►**More Mars Ships**—Air Force is expected to contract for outfitting four more range instrumentation vessels, similar to two vessels now being equipped by Sperry Rand Corp. in the Mars (Mobile Atlantic Range Ships) program. Ships three and four may have greater tracking capability, less capability for calculating re-entry vehicle characteristics than Mars ships one and two. Bid requests for ships three and four may be issued later this year for ships five and six some time thereafter.

►**Unmanned Aerospace Surveillance**—Competitors for unmanned aerospace surveillance and ICBM warning system studies to be issued by Air Force's Electronic Systems Division (AW Feb. 19, p. 23) made oral presentations to ESD recently. One or more large studies are expected to be awarded.

►**Lear Sells Command System Rights**—Sales and manufacturing rights for an aircraft flight instrument system called Lear integrated flight equipment were acquired by Astek Instrument Corp., Armonk, N. Y. from Lear, Inc.

►**REGAL Automatic Landings**—In a continuing series of FAA tests, a Douglas C-54 aircraft has made several completely automatic landings using the Gilfillan REGAL equipment (AW May 18, 1959, p. 137) as the primary position data source. The FAA-owned aircraft was under automatic control by the REGAL system in longitudinal axis from before it began its descent until after touchdown. The aircraft was equipped with a modified autopilot and an experimental flare-out computer by Sperry Gyroscope Co. Previously, an Aero Commander equipped with a flight control system by Lear, Inc., and Sierra Research Corp. made more than 30 fully automatic landings.

►**Yttrium Iron Garnet Shows Promise**—Bell Telephone Laboratories reports that yttrium iron garnet has been found to be an extremely efficient microwave-acoustic transducer, requiring only a small fraction of the power needed by a quartz transducer. This suggests the material will find important uses as an acoustic amplifier, acoustic delay line for radar and computers, and as an acoustic oscillator frequency standard. The microwave energy can be fed into an yttrium iron garnet cylinder by a fine wire loop near the end of the material without requiring direct contact. A microwave pulse in the wire loop generates an acoustic pulse by a magneto-strictive process. As an acoustic resonator, the material has losses at room temperature which are one-tenth those of quartz at a frequency from 1 mc. up into the microwave region, BTL reports.

►**USSR Reports Multi-Wave Light Propagation**—Scientists at the Ukrainian Academy of Sciences have demonstrated that a light wave which penetrates a crystal is split into a large number of waves, some of them polarized, traveling at different velocities and not merely into two waves as previously thought. The amplitude of such waves may be "tens of times greater than those of ordinary light waves," Soviet scientists report. These waves have been experimentally demonstrated in anthracene and cuprous salt and should play a determining role in the photoelectric effect and other phenomena, according to an article in Nauka i zhizn', Oct., 1961, by A. V. Palladin.

Versatile Raytheon tubes count, read, remember, guide, and take X-ray movies

Electron tubes are among the most dynamic and versatile products of modern electronics. From complex scientific instruments probing the reaches of outer space to home television, hi-fi and stereo, tubes have made possible this electronic age. Ever since receiving tubes replaced the crystal in radios, Raytheon has been a leading supplier of electron tubes.

Tubes that count radiation levels, read maps for B-52 pilots, and permit doctors to study the human heart in action are among the specialized varieties produced at Raytheon. Display and storage devices that warn of attack, help predict the weather and guide air and marine traffic are other important products in Raytheon's tube family.

The electron tube is another example of the many electronic skills with which Raytheon serves industry, science, medicine and defense.

Raytheon Company, Lexington, Massachusetts

RAYTHEON



"Frozen" TV and Radar Pictures. A tube that "remembers" — stores TV and radar images into "stills" for immediate study or future reference — has many important applications. Storage tubes, that produce visible trails on the TV or radar screen to show the progressive course of a moving plane or vessel (above), are used in the newest Raytheon air traffic, storm detection, and harbor control radar systems to produce a bright image for easy viewing in a normally-lighted room.



Civil Defense Plans 150,000 Fallout Survey Stations. During the next 4 to 5 years each fallout survey installation will be equipped with one or more precision instruments (right) to monitor radiation levels. Geiger-Mueller radiation detection and electrometer tubes produced at Raytheon for use in these instruments provide an accurate, dependable means of measuring radioactivity for public safety programs.



75% Less X-Ray Exposure. Doctors (above) can now make prolonged examinations of heart action and other body processes by means of the Dynascope, an X-ray image intensifier tube developed by Machlett Laboratories, a division of Raytheon. The Dynascope, by increasing the brightness of a fluoroscope screen 3000 times, makes X-ray movies possible.



Road Maps For B-52 Pilots. The Raytheon "3-Eye" cathode ray tube (right) with optical windows is the basis of a system in which a map is projected onto a screen, and motion pictures are taken of both map and radar image. This cockpit display shows the pilot a continuous map of terrain below and superimposes the radar for later review.



Air Traffic Control Radar Booster. Raytheon's Amphitron (above), a super-powerful microwave tube, is now being added to all air traffic control radars supplied by Raytheon to the Federal Aviation Agency, increasing their detection capabilities as much as 67%. The Amphitron already is an essential part of many of the long-range radars in production or under development.

Can RAYTHEON Electronics help you?

Space Agency's Fiscal 1963 Facilities Plans—Part 1:

NASA Construction Requests Centered

By Edward H Kolcum

Washington—National Aeronautics and Space Administration plans a half billion dollar construction program in Fiscal 1963 on Florida's East Coast and the Gulf Coast as the center of U S space activity moves southward to what is becoming known as the NASA Crescent

The agency is asking Congress for $819 million for its Fiscal 1963 construction programs (AW Mar 19, p 28), and of this, $535 million will be spent at the Atlantic Missile Range, Mississippi Test Facility, Michoud Manufacturing Plant, Marshall Space Flight Center, and Manned Spacecraft Center

Chances are good that two additional facilities will be located in the NASA Crescent—one to manufacture Nova vehicle first and second stages (AW Mar 19, p 25) and another to manufacture the S-2 second stage for Saturn C-5 NASA is actively surveying Gulf Coast sites as potential locations for manufacturing these stages, and is informing Congress specifically that its Nova construction plan dictates a Gulf Coast facility which does not now exist

The Nova manufacturing plant will be designed to receive Rocketdyne J-2 engines for assembly into the S-1 stage, and Aerojet M-1 engines for assembly into the S-2 stage The large size of the stages, NASA says, requires a Gulf Coast location for the plant so that the stages can be carried by barge to the Atlantic Missile Range for mating final checkout and launch

Work stations have been planned as 100 ft modules, to provide 50 ft for the vehicle and 25 ft on each side for access Special assembly area required in the first increment is 353,000 sq ft, half with a 150-ft clearance, and the other half with a 70 ft overhead Lower area will be used to assemble major components, such as the thrust frame assembly, propellant container bulk heads, power unit and cylindrical skin sections It will include three floating assembly platforms which will carry the final assembly fixture by barge to AMR

The high-bay area will contain six bays used to assemble the propellant container and to test, clean and paint it An unspecified amount of conventional-height floor space will be needed for other assembly operations

Initiate Construction

For Fiscal 1963, NASA is requesting $16 1 million, which it says is the minimum to initiate construction of facilities for the N-1 stage Of the total, $13 6 million is for high and low bay areas, $1 8 million for equipment, instrumentation and support systems, and $710,000 for site development and utilities Plant capacity will be eight vehicles a year, with the ultimate size of the plant dictated by Nova launch needs

New facilities planned at the Atlantic Missile Range reflect a solid victory for proponents of the vertical assembly technique, designed to reduce on-pad vehicle time to a minimum (AW Feb 12, p 31) This technique involves receipt of large vehicle stages in a closed assembly building, where stages will be mated on a railroad transporter launcher, and taken through an arming tower to the launch area

The largest single item in the Fiscal 1963 construction budget, the $176 6 million initial construction of Saturn C-5 Complex 39, will be built around the vertical assembly concept, as will the $79 5 million increment for the Nova launch complex

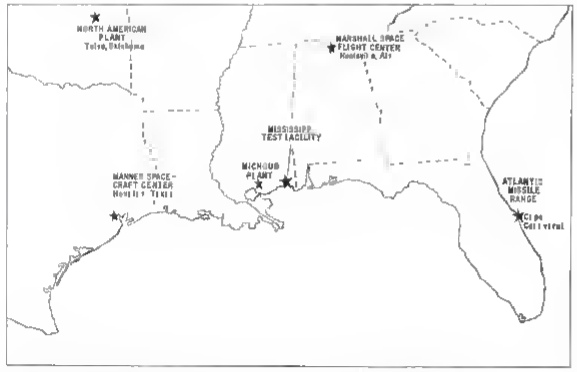
Complex 39 request is estimated to be 40% of the total money needed for the facility, and this is what it will buy

- **Construction** vertical assembly and checkout building, $92 9 million, rail transfer system, $8 4 million, one launch pad, $5 6 million
- **Equipment** propellant services, including high pressure gas, liquid oxygen, fuel and liquid hydrogen, $23 6 million two launcher-transporters, $11 1 million checkout and control, $5 4 million, fixing accessories, $5 million, instrumentation, $2 million, general support equipment, $1 million, deflectors, $775,000
- **Design and engineering**, $16 7 million, utilities $2 2 million, site preparation and roads, $1 8 million

The vertical assembly building will dominate the Cape Canaveral skyline with its 460-ft high bay area The building will be 1,225 ft long with a low bay height of 175 ft It was not determined until recently that the transport method would be by rail Engineers had looked at both barge and rail transportation

Complex 39 is expected to cost about $440 million and consist of three identical launch pads, all connected to the vertical assembly building by the rail system Each pad will have its own fuel storage and feed system Transporter-launchers will be truss-type structures with self-contained drives A 360 ft umbilical tower will be mounted on the transporter launchers Provisions are being made for a fourth pad in the complex, although only three are required for the Apollo lunar mission

One pad would accommodate the C-5 with an S-4B stage payload, another would be a backup for this payload, and a third would have a C-5 with its three-man Apollo vehicle payload Rescue vehicle probably will be a Gemini-type spacecraft, launched by Titan 2 or Saturn C-1



NASA CRESCENT, Florida East Coast and Gulf Coast, is so called because of the concentration of new National Aeronautics and Space Administration facilities in this area

On 'Crescent'

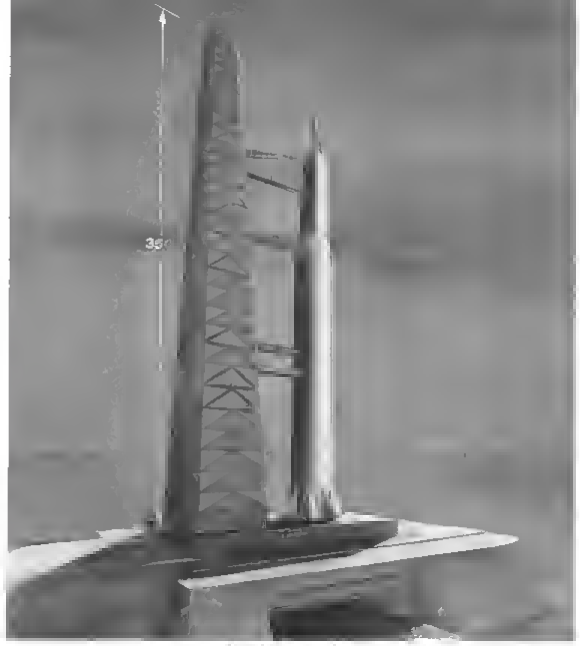
Nova complex is a variation of Complex 39 The N-1 booster transporter will serve as Nova launcher, and assembly of Nova upper stages will be done in the same structure from which the vehicle will be launched The launch building, 470 ft high by 300 ft long, will have a split opening roof through which the vehicle will be launched

Transporter launcher unit will move through canals to the assembly/launch building. After it is positioned, locks will be closed, water pumped and the transporter firmly founded. After launch, water will be pumped back into the locks and the transporter floated for reconditioning and reuse. Ultimate plan is to have three Nova complexes, one a backup Each will have identical vertical assembly-launch buildings, and each will be capable of launching four vehicles annually.

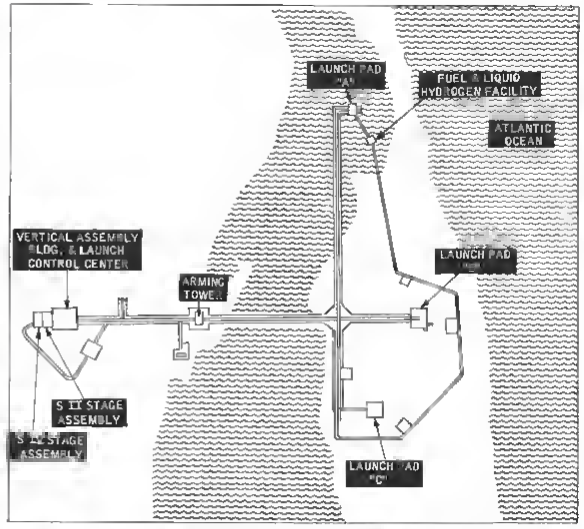
The Fiscal 1963 increment will buy one vertical assembly building $60 6 million, design and engineering services $13 1 million, and site development and utilities, $5 8 million

NASA is requesting $39 1 million for facilities to support the C-5 and Nova complexes, located in the new area of Cape Canaveral, and for another $22 million for utilities installations in this area Major support items are a 1,200 mi inside-outside cable system, $10 6 million, equipment for central telemetry, $6 2 million, precision early launch rate equipment, $4 9 million, central control equipment, $2 1 million precision infrared triangulation system, $1 6 million, a 60,000 sq ft office building to house vehicle contractors, $1 3 million, a 65,000 sq ft engineering, laboratory and operations building for NASA Launch Operations Center, $1 5 million, a central telemetry building, $1 3 million, and extension of communications facilities, $1 6 million Design and engineering services for support facilities will cost about $1 9 million, and site development and utilities, $1 6 million

The $22 million in utilities installations include dredging 18 mi of canal 100 ft wide to a 12-ft depth constructing nine miles of roads and causeways, installation of 22 mi of 110 kv overhead power transmission lines, two



LAUNCHER-TRANSPORTER remains with the vehicle during assembly (AW Feb. 12, p 31) and will move the vehicle to an arming tower, and then to the launch pad



FIRST PHASE of construction of Saturn C-5 Complex 39 will be completion of a vertical assembly building, 460 ft high and 1,225 ft long Maximum of two weeks of pad time will be required in the vertical assembly, present pad assembly time is three months



Engineered Environment

Each fall the female praying mantis brews a frothy foam into which she deposits her eggs. The froth hardens and serves as Nature's "temperature control" to protect larvae until hatching time.

What about *your* problems in temperature control? Among weapons functions there are many requirements for compact, reliable environmental systems. And many such assignments have come to AAF. One example—a special thrust-section heater designed for the Atlas and Titan missiles. The compact heater, operated by remote control, supplies heat to the missile's thrust section during fueling operations and on a stand-by basis.

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110 kv to 13.2 kv substations and 20 mi of 13.2 kv distribution lines, installing 14.5 mi of water main, construction of a 4,600 sq ft dispensary, miscellaneous warehouse and support facilities.

Major Construction

These are the other major construction items at AMR in NASA's Fiscal 1963 requests:

• **Apollo static test** facility, $5 million. This is to be located between Redstone Pads 5 and 6, and will consist of two chambers, to be operated simultaneously for final pre-launch checkout. One chamber will test cryogenic lunar hypergolic engines in the Apollo service module, and the other the lunar module propulsion system. A steam ejector will be used in order to simulate low space pressures.

• **Apollo mission support,** $22.5 million, which includes a spacecraft operations and checkout building, $8.5 million, equipment and instrumentation for this building, $4.7 million, pyrotechnic test, weights and balance building, $1 million, equipment, $595,000, site development and utilities, $4 million, and engineering and design, $2 million. Also included in this request are buildings and instrumentation for reaction control test, environmental system test, ordnance storage, and a shipping and receiving building.

Spacecraft operations and checkout facility will be a three-story masonry and steel engineering and laboratory building to be used for the immediate pre-flight phase of Apollo missions. It will also include a biomedical facility for crew preflight, training simulators, briefing areas and examination and suiting areas.

• **Saturn launch** modifications, $3.8 million for Complex 34, and $1.2 million for Complex 37. At Complex 34, the service structure rail system will be extended from 600 to 1,200 ft and the propellant systems will be hardened as added safety precautions. Service tower, umbilical tower and propellant systems will be modified to accommodate live upper stages. Complex 37 modifications include additional distribution lines in the high pressure gas system, addition of umbilical tower escape systems to both pads in the complex, and modification to the service structure by adding platforms and elevators.

• **Support facilities** in the existing NASA industrial area, $3 million, for a 45,000 sq. ft. launch operations building adding 15,300 sq. ft. to the engineering operations building, constructing a new 33,600 sq. ft. central supply building, and adding 13,760 sq. ft. to the engineering and laboratory annex.

• **Conversion of Titan 1** Complex 19 to accommodate Titan 2 for launching two-man Gemini spacecraft payloads, $2.4 million. This project involves extending the tower structure, adding work platforms on the erector tower, adding a higher capacity jib hoist to handle Gemini payload, construction of a "white room" at the payload level, adding an umbilical boom for the Gemini cable, modifying propellant systems from cryogenic to hypergolic, and increasing bulk storage facilities for the propellants.

Conversion of Complex 19 may be the pacing item for Gemini flights. A four-month engineering and design time will be required, 12 months will be needed for construction, and four months for checkout.

• **Unmanned spacecraft** facilities, $2 million to add 26,960 sq. ft. to the assembly building so that as many as four satellites and probes can be prepared simultaneously for flight, and $450,000 to construct an explosive-safe building for dynamic and static balancing and sterilization of these spacecraft.

• **Little Joe, Sr., launch** complex, $1.7 million, to modify Redstone Pad 5 to accommodate a solid propellant vehicle which will launch Apollo spacecraft and systems on suborbital trajectories. White room will be installed on the service tower, and a new holding mechanism and cables also will be installed.

• **Gemini control center,** $5 million, for modification of the existing Mercury center with new trajectory displays and expansion of telemetry systems to accommodate both Gemini and the Agena B target vehicle.

Mississippi Site

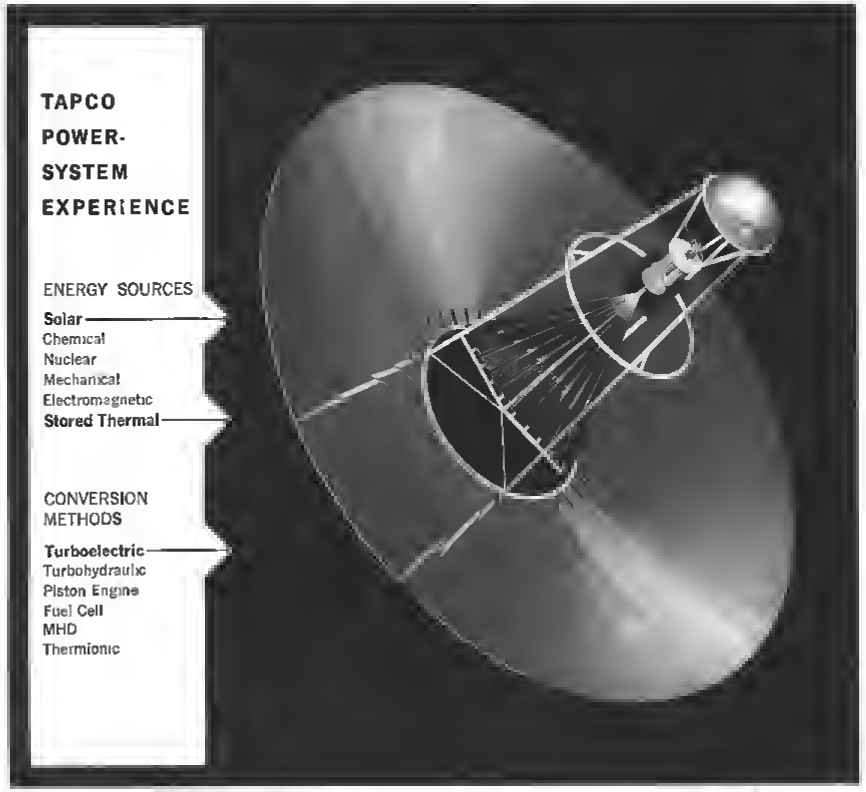
At the Mississippi test facility, initial development and construction is planned on Saturn C-5 and Nova stage test facilities, at a total cost of $92.5 million. NASA is asking for $43 million to build one test position, one instrumentation and control center, one propellant facility and related observation bunkers for each first and second Nova stage. Another $36 million is requested for one complete Saturn booster (S-1C) static test position and early work on another. The S-1C test complex also includes an instrumentation and control center, test support building, observation bunkers, high pressure water system, propellant ready storage and handling facilities, high pressure gas storage tanks and computer center.

By far NASA's largest installation at 141,950 acres, the Mississippi site eventually will have three N-1 static test positions, three S-1C positions, two for S-1 stages, two for S-2 stages, three for N-2 stages, and one each for single F-1 and M-1 engine tests.

Cost breakdown for Fiscal 1963 projects is:

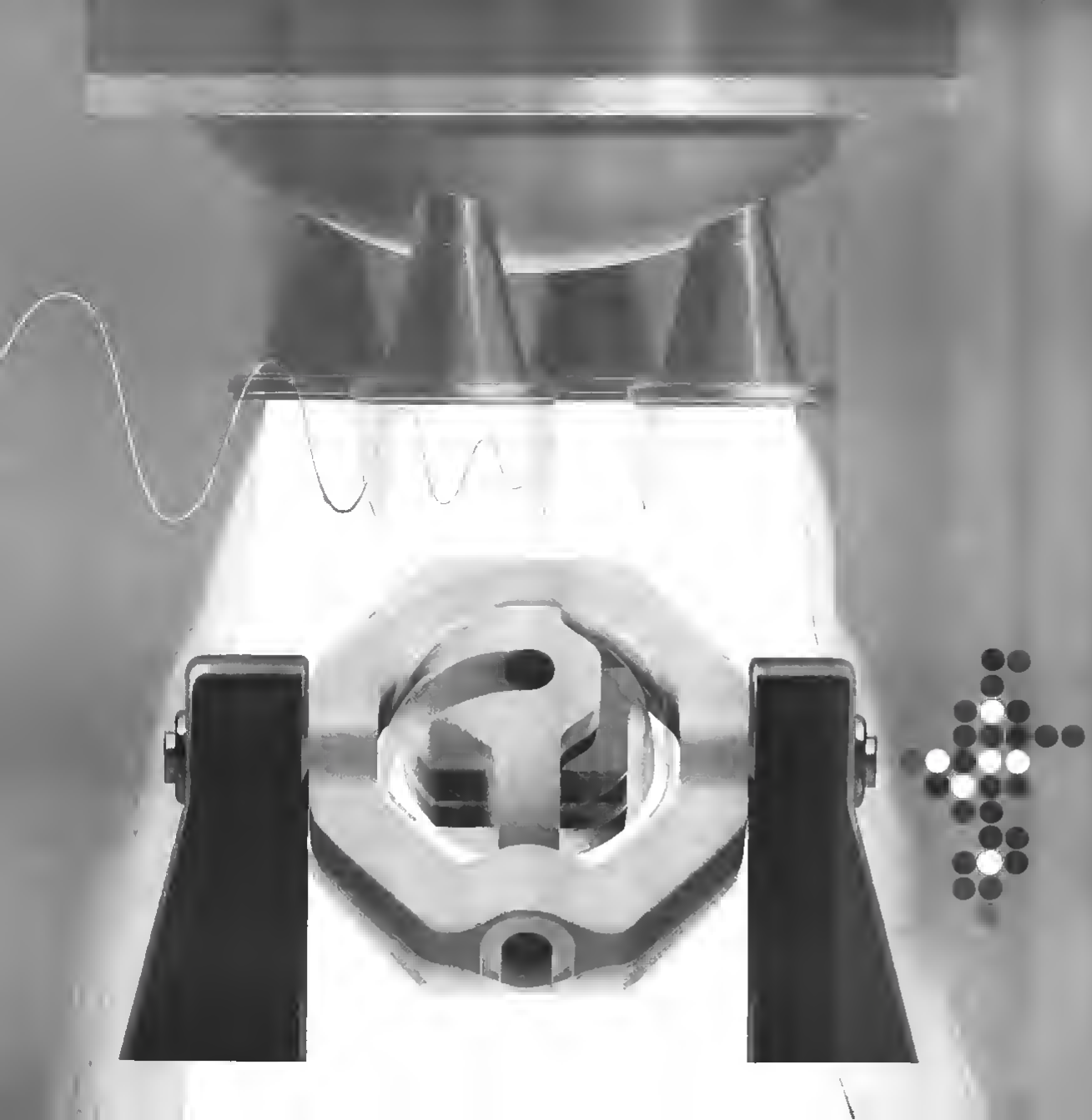
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Sunflower Space-Power System: A mercury closed Rankine cycle configuration adaptable to wide range of Earth, Moon, Mars and Venus missions. Solar radiation and LH heat of fusion are energy sources, the latter acting during dark periods of orbit. Mercury vapor driven turboalternator converts energy to electric power. Space radiator rejects waste heat. Packaging and deployment of solar collector are effected by employing radial petals hinged at I.D. Independent orientation of vehicle and collector is possible. System shown is for Earth orbits ranging from 300 to 20,000 nautical miles altitude. System provides 3 kw, a-c power continuously for at least one year. Tapco, a division of Thompson Ramo Wooldridge Inc., 23555 Euclid Avenue, Cleveland 17, Ohio.

DESIGNERS / MANUFACTURERS FOR SPACE, MISSILE, AIRCRAFT, ORDNANCE, ELECTRONIC, NUCLEAR INDUSTRIES



LABORATORY LAUNCH PAD

"In-house" missile flights are a daily occurrence at Lockheed Missiles & Space Company. The advantages of "flying" the POLARIS FBM inside the laboratory, on an amazing internally-developed simulator, are obvious.

The simulator performs many developmental and test functions. When the missile is first conceived, performance characteristics are cranked in, basic overall requirements are read out. Later, the simulator details the functional requirements of each subsystem and calculates specifications for hydraulic, electronic and pneumatic hardware. As each component is built, it replaces its computer counterpart.

Finally, the whole guidance and flight control package is put through simulated flights for final checkout. But that isn't all. The simulator also performs the role of post-flight evaluation detective when it is fed tapes of actual flights, and the effects are observed on earth-bound hardware.

It is with such elaborate equipment, guided by engineers and scientists of outstanding calibre, that Lockheed Missiles & Space Company has attained its place in the forefront of missile and space technology. And such progress is constantly creating key positions for other engineers and scientists of proved ability, so they may take up the exciting challenges offered by Lockheed and share in its rewards.

This unusual organization is located in Sunnyvale and Palo Alto, on the San Francisco Peninsula in California. For an informative brochure, "Your Place in Space," write to: Research and Development Staff, Department M-31F, 599 North Mathilde Avenue, Sunnyvale, California. An Equal Opportunity Employer.

LOCKHEED *MISSILES & SPACE COMPANY*

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS programs. Other current programs include SAINT, AOVENT and such NASA projects as OGO, OAO, ECHO and NIMBUS.

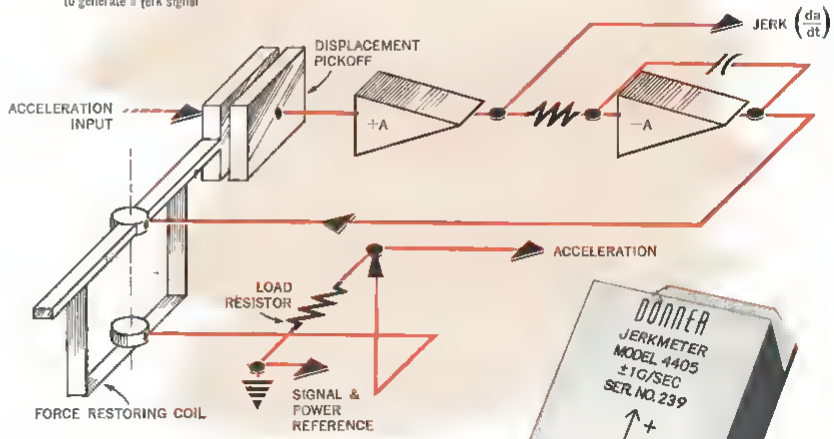
SUNNYVALE · PALO ALTO · VAN NUYS · SANTA CRUZ · SANTA MARIA · CALIFORNIA
CAPE CANAVERAL · FLORIDA · HAWAII



OGO will check in here

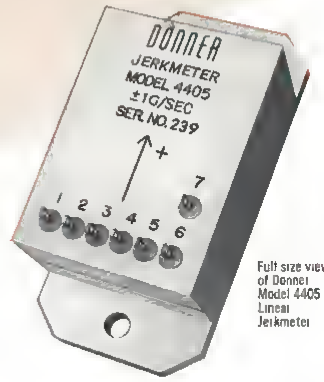
Soon a new space chamber 30 feet in diameter will fill this deepening bowl of earth. Here OGO (NASA's Orbiting Geophysical Observatory) will be subjected to conditions of solar heating, vacuum, and vehicle radiation to the cold of outer space. The new space chamber will be the sixth at STL. It will enable engineers and scientists working on OGO, Vela Hotel and other STL projects to test large, complete spacecraft as well as major subsystems. And along with other advanced facilities at STL's Space Technology Center, it will provide unusual scope for engineers and scientists to verify and apply new techniques in design, development and fabrication of spacecraft. STL's expanding space programs have created new opportunities for engineers and scientists in the following fields: Aerodynamics, spacecraft heat transfer, Communication Systems, Electronic Ground Systems, Power Systems, Propellant Utilization, Propulsion Controls, Reentry Body Evaluation, Systems Analysis, Thermal Radiation and Trajectory Analysis. All qualified applicants are invited to write Dr. R. C. Potter, Manager of Professional Placement and Development, for opportunities with STL in Southern California or at Cape Canaveral. STL is an equal opportunity employer.

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Functional diagram of Donner Linear Jerkmeter. This unique instrument operates as a subminiature servo system of the force-balance type which is responsive to jerk along the sensitivity axis of the linear unit and about the sensitive axis of the angular unit. Basically, the system consists of a transistorized accelerometer with an integrator inserted into the servo-loop to generate a jerk signal.

HOW TO MEASURE $\frac{da}{dt}$



Full size view of Donner Model 4405 Linear Jerkmeter

New Donner precision Jerkmeters measure linear and angular jerk to ±0.5% or better.

If your measurement and control problem requires accurate measurement of jerk or the rate of change of acceleration, Donner Scientific's new line of precision angular and linear jerkmeters can help.

These new instruments are the only truly accurate device of this type ever made. They are designed to meet the most demanding applications. Both angular and linear jerkmeters provide an output voltage proportional to jerk which in turn can be used to instigate compensatory control forces or other actions. *An acceleration analog output voltage is also available.*

Typically, a jerkmeter installed in a jet aircraft will provide an instantaneous output proportional to the rate of change of g's. This signal can be used to predict impending disaster conditions.

Other applications include use wherever constant acceleration is required. Here, the Donner jerkmeter provides a "velocity damping" term. The jerkmeter also provides a third order term for stabilizing displacement devices. It can also be used as an inertial indicator of first motion.

KEY SPECIFICATIONS for Model 4405 Linear Jerkmeter

RANGES
Acceleration: ±1 g full range to ±30 g full range
Jerk: ±0.5 g/sec full range to ±20 g/sec full range

OUTPUT FULL SCALE
Accelerometer: ±7.5 v dc
Jerk: ±7.5 v dc

RESOLUTION
0.1% full scale or better

LINEARITY
0.1% full scale or better

HYSTERESIS
Less than 0.1%

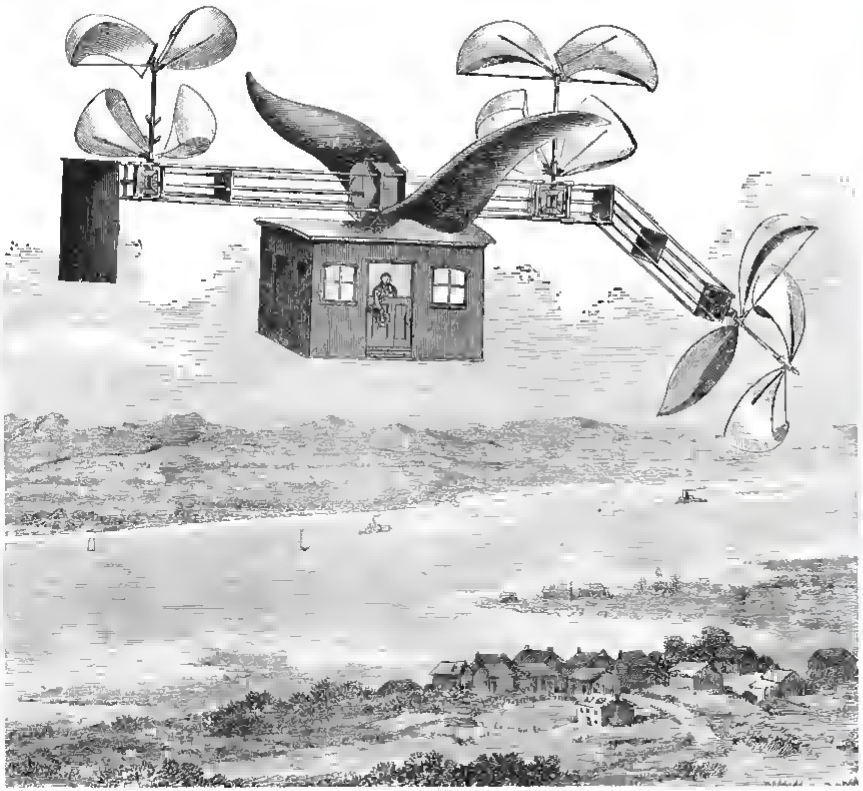
POWER
+15 v dc at 10 ma and −15v dc at 10 ma

SIZE
3" long, 1½" wide, 1⅝" high

WEIGHT
7.5 ounces

WANT MORE INFORMATION? *The new Donner Jerkmeter is another product from a firm specializing in the manufacture of accurate fixed and general purpose analog systems designed to analyze, measure and control inputs interlocking time, acceleration, jerk, velocity and other dynamic inputs. Complete technical information can be obtained by calling your nearby Donner engineering sales representative or writing.*

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ENGINEERS AT ASTRONAUTICS 'ORBIT THE EARTH'

In this mockup model of "MARS — Manned Astronautical Research Station —engineers are making simulated space flights at General Dynamics | Astronautics in San Diego California

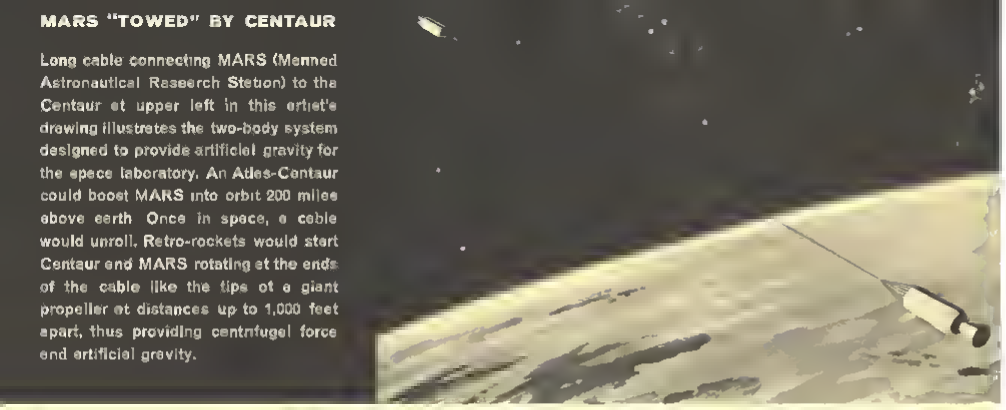
The MARS vehicle, placed in orbit by Atlas Centaur (also designed and built by Astronautics) could take three astronauts 200 miles into space for almost a month of scientific studies

MARS typifies the advanced planning and technical resourcefulness that have made General Dynamics | Astronautics an ideal association for space minded engineers We're also at work on such Atlas Centaur programs as *Mariner*—a deep space probe to the vicinity of the planet Venus—and *Surveyor*, which will soft-land an instrumented package on the moon

Atlas-Centaur is the free world's first space vehicle to be powered by liquid hydrogen It not only opens our entire solar system to research but creates extraordinary opportunities for engineers who look beyond the present state of the art — men who are somehow not content with the status quo

If you're that sort of man, we urge your inquiry It entails no obligation, of course, and may prove to be of tremendous mutual advantage Use the attached Professional Inquiry Card, or write in confidence to Mr R M Smith, Manager of Industrial Relations Administration-Engineering, Department 130-90, General Dynamics | Astronautics, 5728 Kearny Villa Road, San Diego 12, California

GD
GENERAL DYNAMICS | ASTRONAUTICS



MARS "TOWED" BY CENTAUR

Long cable connecting MARS (Manned Astronautical Research Station) to the Centaur at upper left in this artist's drawing illustrates the two-body system designed to provide artificial gravity for the space laboratory. An Atlas-Centaur could boost MARS into orbit 200 miles above earth. Once in space, a cable would unroll. Retro-rockets would start Centaur and MARS rotating at the ends of the cable like the tips of a giant propeller at distances up to 1,000 feet apart, thus providing centrifugal force and artificial gravity.

Immediate openings exist in the following categories:

Base Activation

Design or liaison engineers with BS in ME or EE and experience in electrical or mechanical systems are required for liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations. Assignments are at Lincoln, Nebraska; Altus, Oklahoma; Abilene, Texas; Roswell, N. M.; and Plattsburgh, N. Y.

Field Test Engineering

BSEE, AE or ME with field test or design experience in the following:

Electrical & Electronic Systems

(Launch controls, logic control systems, communications systems, automatic checkout equipment, guidance and flight control facility electrical power and electronic systems.)

Mechanical Systems

(Fluid transfer, propulsion, liquid and gas dynamics, air temperature control and missile lift.)

Openings exist at Vandenberg AFB, Santa Maria, California and Cape Canaveral, Florida.

Electrical Design

A number of assignments are available in the design of launch control systems, packaging, test equipment, missile electrical power systems, and component and systems tests. Openings also exist in vendor qualification, selection and test of ground and airborne missile electrical equipment, as well as design. A BSEE or MSEE and appropriate experience are required.

Computer Programming

For integrated data processing with both engineering and non-engineering application on 7090 and 7070. PhD, MS and BS degrees in math, physics or business administration with 4 years of experience programming for 704, 709 or 7090 computers.

Electronic Engineering

BS or MSEE with applicable experience required for assignments in telemetry, radiation systems, trajectory measurement, tracking, guidance, automatic controls, packaging, instrumentation, digital devices, printed circuitry, logic design, component and systems testing, or measurement systems. Openings exist in design, development, reliability, vendor qualification, selection and test on ground and airborne electronic components, subsystems and systems.

Reliability Engineering

These assignments involve the establishment of electrical/electronic reliability requirements, conducting tests and test analyses and maintenance of reliability program surveillance. A background in systems test or analysis and a BSEE are required.

Mechanical Design

BSAE or ME to design and develop missile airframes, ground support equipment, hydraulic or pneumatic systems.

Technical Writing

Varied openings are immediately available to capable writers. Assignments involve technical reports and manuals, manual subcontractor control, manual change control, technical manual verification and proposal writing. Background should include experience in technical publications and some college or formal technical training.

Openings also exist in these other specialties:

Circuit Design, Data Transmission Design, Liaison, Dynamics Engineering Administration, Field Service, Flight Test, Guidance Systems Analysis, Human Factors, Logical Design, Metallurgy, Microwave Design, Quality Control, RF Circuitry, Structural Design, TV Engineering, Telemetry and Thin Films.

If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Manager of Industrial Relations Administration-Engineering, Mail Zone 130-90, General Dynamics/Astronautics, 5728 Kearny Villa Road, San Diego 12, California.

GENERAL DYNAMICS | ASTRONAUTICS

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• **Nova stages.** N-1 test stand, $7.3 million; deflector, $1.8 million; N-2 stand, $4.9 million; deflector, $1.2 million; twin control centers, $2.9 million; four observation bunkers, $40,000; design and engineering, $8.5 million; component, equipment and instrumentation, $15.1 million; and site development, $1.2 million.

• **Advanced Saturn.** S-1C test stand, $6 million; deflector, $1.5 million; foundation for second stand, $1.1 million; control center, $1.6 million; fuel storage tanks, $4.1 million; water tanks, $1 million; test support building, $120,000; two bunkers, $10,000; instrumentation and equipment, $15.9 million; design and engineering, $3.7 million; and site development and utilities, $1.1 million.

• **Utility installations.** $13.5 million for roads, water lines, natural gas and electric power distribution as well as heating plants.

NASA Crescent

Approximately 90% of the activity of the Marshall Space Flight Center, the most inland facility of the NASA Crescent, is devoted to the manned lunar landing program. NASA is requesting $33.4 million for new facilities at Marshall, of which $10.3 million will be used to expand support facilities and utilities at the center. In these categories are projects to increase the high pressure water system pumping capacity from 70,000 gpm. to 220,000 gpm., increase fuel storage capacity from 50,000-250,000 gal., increase liquid oxygen storage capacity from 75,000-375,000 gal., renew the helium pressurizing gas system and install a liquid nitrogen system.

Water, sewer, electric and road systems throughout the center will be expanded and improved.

Remainder of the construction at Marshall is for development, test and research and support of these activities. Major item is a single-unit static test, calibration and evaluation stand for the Rocketdyne F-1 engine, to cost $4.5 million.

This stand will be used for development of N-1 and S-1C booster stages and will complete work started under a fiscal 1962 $1.5 million allotment.

Marshall Projects

Other Marshall projects:

• **Expansion of West Area instrumentation systems,** $4 million, to support the second Saturn static test stand being constructed.

• **Modify existing Saturn C-1 test stand** so that it can accommodate twin test positions, $2 million.

• **Components test facility,** $4 million, to modify the existing components test laboratory, install a new instrumentation system and cable transmission tunnel, construct a new control and operations center and construct two multi-purpose dual test stands to test vehicle and propulsion system components.

• **Research projects** addition of 34,700 sq. ft. to the computation building, $1.3 million, for vibrational telemetry, optical, data translation, plotting, digital and three-axis flight simulator equipment; components acceptance building, $950,000; for inspection and test of engine and stage components and subsystems; hydraulic system test facility, $340,000; low temperature facility to test materials in the liquid hydrogen (−423F) range, $575,000; instrument laboratory for design, development, calibration, repair, modification and evaluation of instruments to be used in static test and in the cold flow programs, $2 million.

• **Engineering and administration** build-

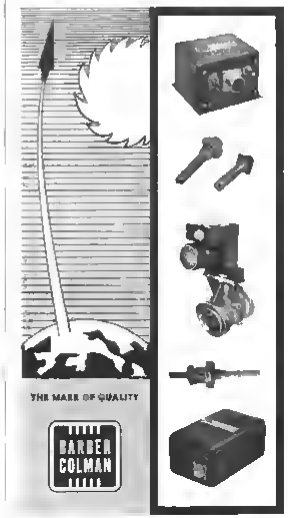
NASA Field Establishment

Installation	First used by NACA/NASA	NASA area (acres)	Value[1] (millions)	FY '63 construction (millions)
Atlantic Missile Range	1958	72,994	$154.9	$360.0
Mississippi Test Facility	1961	141,950	26.0	92.5
Nuclear Rocket Development Station	1961		15.0	40.0
Plum Brook Station	1956	5,968	28.1	39.2
Marshall Space Flight Center	1960	1,617	99.2	33.4
Manned Spacecraft Center	1961	1,620	60.0	30.8
Goddard Space Flight Center	1959	578	50.7	23.8
Michoud Plant	1961	825	50.0	18.4
Ames Research Center	1940	115	124.5	14.4
Jet Propulsion Laboratory	1958	158	43.4	10.4
Langley Research Center	1917	772	231.2	8.1
Lewis Research Center	1941	350	150.7	4.6
Wallops Station	1944	4,335	24.2	4.3
Flight Research Center	1946	170	9.9	1.8
Pacific Missile Range	1959		11.5	
Various Locations				127.3
Totals		231,452	$1,079.3	$809.0

[1] Includes FY 62 construction now under way.

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Since the "thirties" and Boeing Chipper days, Barber-Colman temperature controls have made significant contributions to many of the nation's major commercial, military, and business aircraft.

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The S-C 3070 puts current preflight weather data in the hands of pilots faster than ever before! The printer utilizes an electrostatic process to produce highly legible, permanent copy. The S-C 3070 is designed to operate at speeds up to 3,000 words per minute using standard computer or communications codes over telephone, telegraph and microwave links. ■ Compact dimensions and quiet operation make the S-C 3070 ideal for communications or command centers. Multiple copies of S-C 3070 output can be easily obtained by using the original as a litho offset master or by standard office copying methods. ■ Reliable, unattended operation in the S-C 3070 results from the unit's non-impact printing concept and field proven electronic circuitry. Replacement paper rolls can be loaded into the S-C 3070 without interfering with message transmission. ■ For additional information on the S-C 3070, write to Dept. C-69 General Dynamics | Electronics, P.O. Box 2449, San Diego 12, Calif.

GENERAL DYNAMICS | ELECTRONICS GD SAN DIEGO

Nuclear Detection Method

New York—Detection of high-altitude nuclear explosions by the altered radio propagation characteristics of the D-layer in the ionosphere will be studied by Sperry Gyroscope Co. under a $31,000 USAF contract.

Sperry's Air Armament Division will attempt to define the normal characteristics of the D-layer, generally believed to be between 40 and 250 mi. above the earth, by bouncing radio signals off this ionized region and measuring the time lapse and amplitude of the return signal. Sperry's theory is that nuclear debris will increase the density of this layer, dropping the region's lower level and enhancing the return signal.

Sperry will use the 1,000 kc. transmitters of Loran-C long-range navigation stations both for the initial determination of the layer's radio background and, later this year, in the Pacific against actual nuclear explosions.

ing to house 850 people, $2.5 million and an engineering building to house 250, $1 million.

Another $2.5 million has been requested to improve water, sewer, power, road and bridge systems at the center.

Manned Spacecraft Center, 25 mi. southeast of Houston, will have $30.8 million in Fiscal 1963 for construction of requests are approved. The site is under development and most of the center staff are housed in office buildings in Houston. The 1,620 acre tract includes 1,020 acres deeded to the government without cost last year by Rice University, and 600 acres being purchased. There is a 20-acre drilling site adjacent to the lunar landing simulator for which the Humble Oil and Refining Co. has an easement. Humble gave the property to Rice but retained mineral rights.

The center's major construction program in Fiscal 1963 is a flight acceleration facility to cost $10.6 million. Lunar landing simulator will cost $6.6 million, and thermochemical test facilities, $6 million. Site development and utility installations will cost $7.6 million.

The flight acceleration facility will be a 40g centrifuge with 3 degs. of rotational freedom. There will be five interchangeable gondolas one each for acceleration tests in combination with heat, humidity, pressure, light and sound variations. Arm length will be about 100 ft.

The facility will be used to perform the following functions:

- Integrate pilot tasks with cabin design.
- Develop and evaluate restraint systems and protective devices for pilots.
- Evaluate critical mechanical systems sensitive to accelerations.
- Further study human tolerance in specific acceleration profiles to be experienced in Gemini and Apollo missions.

The lunar landing simulator will be used to train crews in landing the Apollo vehicle, and in staging mechanics, lunar launch operations, flight separation of modules aiming an abort spacecraft docking and crew and cargo transfer from one module to another.

The main facility will be a 60,000 sq. ft. test chamber with a 210-ft. hall. Two carriages will be used for training crews, in free or tethered flight. One can accommodate up to 75,000 lb., and the other 25,000 lb.

The training vehicle will have propulsion, connections and visibility identical to those in the Gemini and Apollo vehicles.

The facility will be used to develop landing and flight systems and techniques, and will be used to evaluate parachutes, rotating wings, flexible wings, personal parachutes, impact rigs and other landing shock attenuators.

The thermochemical test facility will be used to evaluate and develop spacecraft propulsion, reaction and attitude control, auxiliary power and thermal control systems.

It will consist of a high thrust liquid propulsion test cell, a high thrust solid propulsion test cell, a cryogenic test cell, reaction control facility able to test systems with thrusts up to 150 lb., chemical auxiliary power test facility, thermochemical and thermal control laboratories and a single-axis air bearing table for attitude control system evaluation.

Thermal control facility will accommodate Apollo-size modules in a pressure chamber able to be pumped to 10^{-6} mm. of Hg.

The other installation in the NASA Crescent is the Michoud Plant, a government-owned World War 2 assembly facility valued at $50 million which was acquired by the space agency last year. Construction requests at the plant for Fiscal 1963 total $15.4 million. Principal item is modification of the manufacturing building to adapt the plant for Saturn S-1 and Saturn S-10 booster fabrication and assembly.

Chrysler Corp. will assemble the S-1 stage—a cluster of eight Rocketdyne H-1 engines—and Boeing Co. will manufacture the S-IC stage—a cluster of five Rocketdyne F-1 engines. To cost $11.4 million, the modifications consist of a Saturn dock access and rehabilitating the manufacturing building air conditioning, construction of fabrication and assembly areas, modification of the former dry kiln shop for storage, installation of a data processing and computing area, modifications to the hammer and foundry buildings, and construction of a pneumatic checkout cell.

Companion hydrostatic test and cleaning and vertical assembly buildings will be built for the S-IC stage, at a cost of $3 million each. The test and cleaning building will be 90 ft. high and will be used for major subassembly of fuel tanks, aft tank head section, center tank shell baffle assembly, and forward fuel tank head section. Cleaning will be done with deionized water, detergent and trichlorethylene.

Overhead clearance in the assembly building will be 180 ft., and a 150-ton crane will be its major equipment item.

Final construction project at Michoud will be a high pressure test cell to be used in evaluation of fuel tanks and tubing.

Hydrostatic pressure capability will be 10,000 psi., and pneumatic pressure, 4,500 psi.

Facilities construction at the Marshall Rocket Development Station, Plum Brook Station, Wallops Station and Goddard, Ames Jet Propulsion Laboratory, Langley, Lewis and Flight Research Centers will be described in Part 2.

(This is the first of two articles examining NASA's Fiscal 1963 construction program.)

Bioastronautics Proposal

Washington—Greater use of Air Force's bioastronautics capability in National Aeronautics and Space Administration programs is the key recommendation of a report submitted to the National Aeronautics and Space Council recently by the White House-appointed panel that has been reviewing the nation's efforts in this field for the past several months.

The panel, which was directed by Dr. Paul Beeson of Yale University, assisted by Dr. James Hartgering, special assistant in the President's scientific advisory office (AW Aug. 21, p. 26), also suggested that greater attention be given to basic bioastronautics research.

The recommendation that USAF and NASA work more closely together has been made before by various congressional, industry and USAF spokesmen, but was never wholeheartedly accepted by NASA.

Major conclusions are to give the bulk of aerospace medical responsibilities to the Defense Department and responsibility for radiological protection to the Atomic Energy Commission. Instead of building its own biomedical capability, NASA would lay requirements on Defense Department if recommendations of the report are followed.

AMR Foresees 5-yr. Instrumentation Bill

By David A. Anderton

Patrick AFB, Fla.—Cost of new instrumentation systems for Atlantic Missile Range, necessary because today's requirements for accuracy and precision of measurement are not being met, could approach $1 billion spread over the next five years.

This sum is nearly equal to the current capital investment in AMR. If funds of this magnitude become available, they will be spent largely to improve the instrumentation environment and therefore the accuracy and precision of the test data.

At the root of the problem is a group of six major technical difficulties which confront AMR operators and users, but which are also applicable to the other service and national range installations in this country and abroad. These six problem areas were described by Dr. G. S. Blevins of Pan American World Airways at a recent symposium here on range instrumentation (AW Mar. 19, p. 30).

- **Acquisition** of accurate metric data, particularly position and velocity data for missiles and space vehicles at launching, injection, re-entry and impact.
- **Transmission** of data through the re-entry blackout, the region where intense ionization of the atmosphere around the re-entering object attenuates or blankets transmission to or from the vehicle.
- **Impact location,** which due to a large number of inaccurate bases can only be measured within about one-tenth of a mile now.
- **Mobile instrumentation** which maintains the same accuracy of measurement as its fixed counterpart, and which could be positioned accurately on land or sea.
- **Reliable long-range,** high-rate data transmission in real time.
- **Evaluation** and calibration of instrumentation.

Both operators and users of current ranges agree generally on one starting point as the basis for all their arguments about instrumentation. At no time during a flight test, except when the vehicle is at rest on the launching pad, is its position known exactly enough to satisfy the engineers conducting the tests.

Representatives of AMR, other ranges, and the range users agreed during the three-day session that these problems were common to all. But in addition, the specialized environments or requirements at some ranges increased the list by several items.

Dr. Kurt H. Debus, who directs launching operations at AMR for National Aeronautics and Space Administration, told the symposium that NASA wants to be able to get its tracking and computing in near real time. Coupled with this, Debus suggested displays for all information pertinent to the particular flight being monitored, plus positive transmission of decision-making signals.

NASA's future instrumentation systems for space flight have to go in either one of two directions, Debus said—a huge number of linked tracking stations with central control, or decentralized network with positive handover of control.

Because below-horizon tracking is not available, Debus suggested that a satellite system would be required to meet the instrumentation and tracking needs with direct line-of-sight contact possible between the object being tracked and the controlling ground station.

For orbital operations, Debus said current systems would be adequate for rendezvous, providing supplementary aids were used.

Blevins contrasted current capabilities and requirements of AMR instrumentation systems for launch and injection with projected capabilities and future requirements (see box). In no case are future needs matched by prospective future systems.

But current problems on the range are just as difficult in other regimes, Blevins said. In re-entry from ballistic shots, there is often a large cluster of bodies instead of a single vehicle, and the first problem is to sort out the desired object. Having done that and tracked it through re-entry, the next problem is measuring the location of the impact point. Blevins indicated that this measurement was good within about one-tenth of a nautical mile in ocean areas. This figure was later confirmed to AVIATION WEEK by a range user, who added that the requirement is to measure the impact point within 25 to 100 yd., which calls for considerably better accuracy than that now available.

Currently there are three MILS (Missile Impact Locating System) nets using acoustic hydrophones, their locations are at Grand Turk, Antigua, and Ascension. Grand Turk is suitable for missiles in the Redstone class, and Antigua for Thor and Jupiter firings. Neither of these is being fired in missile development now. The Ascension area is adequate for measuring normal-range Atlas impacts, but is not adequate for the long-range Atlas or Titan shots.

Consequently the current need is for mobile impact-point detectors. AMR is studying the STAR (Ship-Tended Acoustic Relay) system, an all-acoustic method for measuring impact location and ship positions. STAR systems will be able to measure the impact point, and also to locate the position of BOA (Broad Ocean Area) calibration and tracking ships. The BOA system uses small, one- to four-pound Sofar bombs in the re-entering vehicle. The bomb is triggered after penetration to the "Sofar layer" of the ocean about 3,000 ft. down. The explosion is recorded now at land-based stations.

Until the STAR system is operative, an interim system will receive, record and transmit Sofar data from a single location in the BOA network.

Most of the problems could be solved by improved instrumentation, Blevins said, but there is still one remaining hurdle: calibration of the instruments and determination of their position with reference to base data. One of the most typical examples is that of ship-based equipment. Current ship positions can't be plotted within a half mile to two miles. Consequently the accuracy of the ship's tracking radar data has to be modified by an assumed ship-position accuracy. Blevins said the requirement for ship-based instruments is to be able to locate the ship itself within 500 ft. or less.

One reason for the large number of night firings at AMR is the current inaccuracy of tracking radars compared with ballistic cameras. The cameras, which can furnish data accurate to about 10-15 parts in a million, are used to photograph the missile track at night. The photographs include star locations which are used in turn to determine the missile path. Point-by-point comparison of the photographed trajectory and the radar-tracked trajectory is used to calibrate the radars. The photo data also furnishes initial data for mathematical construction of the Keplerian ellipse which contains the trajectory.

Here the minimum requirement is one part per million, Blevins said, rather than the current 10-15 ppm. But the astronomical star catalogs used to calibrate the cameras and to fix the position of the missile in space, are not that accurate. So the problem begins to center on the physical standards themselves, those constants in quantities used for calibrating instrumentation or determining its initial location for reference. Blevins pointed out these examples:

- **Surveying accuracy,** which determines the location of land-based stations can be held between one and 20 parts per million. The accuracies are at the low end of that scale in the mainland, and at the high end on islands.
- **Index of refraction** of the atmosphere, which is an initial error in calibration of optical instruments, is known to about 25 ppm. It should be determined within 1 ppm.
- **Time correlation** of events along the tracking network is good to about 100 microseconds now, but should be good to 10 microseconds.
- **Velocity of light,** used in optical instrumentation calibration needs to be known to one more significant figure. It is estimated at one part in 500,000.

In contrast to the long-range and space missions of AMR are the jobs of the White Sands Missile Range. These fall into three completely different categories, said Charles W. Mullis, limited war missiles requiring accurate launching and impact data; ballistic launches, requiring knowledge of the upper atmosphere; and WSMR's newest assignment, the ARPAT (Advanced Research Projects Agency Terminal) program, which involves the accurate tracking and—in most cases—recovery of re-entry vehicles.

Initial users in WSMR instrumentation come from the geodesy, which Mullis described as grind right now. But the long-base lines in the order of 100 mi. are known only to one in two feet, which corresponds to 1.7 to 3.5 ppm.

In addition to measuring position and velocity of missiles, WSMR data frequently must include missile acceleration and "jerk," which is the rate of change of acceleration. One indication of the accuracy expected was given by Mullis. Accelerations should be determined to 0.001 ft./sec.² sec.

Another major factor which affects the mission of WSMR is the need for real-time data. Within a year, the range operators expect to be tracking missile targets. For this job they want to get data at a sampling rate of 50 bits per second with a time constant of 10 milliseconds anticipated. "In tracking WSMR has specified both range rate radar and phase-comparison systems. Both these systems need cooperative targets both are complex, and both require special operator talent. Phase comparison system will have the better accuracy, Mullis believes, but the radar data is easier to handle and edit.

For the ARPAT program, many of the shots will use power on the downwind portion of the flight path. The studies require knowing orientation of the re-entry vehicle, and the best way to accomplish this is with a ground-based system. But such a system does not now exist, and the orientation data currently is telemetered to the ground from on-board sensors.

Mullis emphasized one aspect of re-entry that complicates the problem: radiation of energy from the re-entering body over the entire spectrum from soft X-rays at one end to the same energy of the shock front.

Radar camera is another difficult task to be imposed on WSMR during these tests. In one special phase the range is requested to furnish data on the dimension changes of re-entry vehicles during flight to within a few thousandths of an inch. Rescue before impact is therefore important.

Many techniques have been developed for location and recovery of payloads from the desert floor in range at White Sands. Aerial spotting, optical or radar triangulation for impact prediction, smoke bombs and the like have been tried in different types of missions. Now WSMR even uses dogs which have been trained to locate and dig up small objects to be recovered.

One other aspect of the range's future mission is of eminent concern. There will be a need to track and record data on several missiles and several targets at one time, which may or may not be in formation and in the same area of sky. "Under these conditions how do you handle range safety?" Mullis asked.

Calibration imposes more stringent conditions on initial instrument error at WSMR than at AMR, according to some of Mullis' examples. He said WSMR needs to know both the index of atmospheric refraction, and the

Atlantic Missile Range

Accuracy of Metric Data During Launching Phase

	1961 Capability	Future Requirement
0-500 ft		
Position	1.5-3.0 ft	0.1-0.01 ft
Velocity	0.4-1.5 fps.	0.01-0.01 fps
500-25,000 ft		
Position	2.0 ft	0.1-1.5 ft
Velocity	1.0-1.5 fps.	0.1 fps.
25,000 ft — Burnout (200-5,000 naut. mi.)		
Velocity accuracy requirement	0.1 fps. (1962)	0.01 fps. (future)
Velocity accuracy capability	1 fps. (Azusa system at 200 naut. mi.)	0.5 fps. (Minitrack system at 580 naut. mi.)

Note: Launch phase starts at the site and continues to first burnout in the case of ballistic missiles, or to the end of first-stage boost in the case of space vehicles.



MARTIN TITAN ICBMs are shown at Vandenberg AFB training facility 1 area. Overall view shows missiles erect on pads 1, 2, and 3.



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velocity of electromagnetic propagation in the atmosphere to one part in 20 million. Or as an alternate, suggested Mullis, "... develop a system independent of atmospherics, having the same accuracy, and using Indian's technology."

S-band telemetry seems mandatory for future systems, said Kenneth Lichti of Pacific Missile Range. But even with the abandonment of the crowded VHF portion of the spectrum in favor of the S-band region, there will still be problems of crowding. Currently there are studies and special assignments of frequencies in the range of 1,435-1,535 mc, Lichti said, and some equipment operating in the 2,200-2,300-mc region. He suggested it might be necessary to develop telemetry at frequencies even higher than those of the S-band.

F. M. Ashbrook of Naval Ordnance Test Station at China Lake seconded Lichti's suggestions about microwave telemetry. NOTS surveyed the current status of available equipment and found that size and cost are the major problems. There are about 10-12 pre-amplifiers and receivers available—roughly the same number of antenna systems, and less than 10 amplifiers and transmitters on the market.

Ashbrook said that telemetry efforts in the 1,435-1,535-mc and 2,200-2,300-mc frequency bands are just starting.

PCM Systems

In another type of telemetering system, the PCM (Pulse Code Modulated) units used on Titan and Minuteman, technical progress is being pushed to its limits, one range user told AVIATION WEEK. He said that the Atlantic Missile Range had no tape recorders which could handle the PCM systems of those two ICBMs, and there was little prospect of getting them as standard equipment. Finally the purchase of proper tape recording equipment was made using Minuteman funds.

NOTS' most unusual problem has to do with its underwater work. As Ashbrook put it: "If you think you are having troubles pinpointing missiles in the air, try finding them under water." Current systems are based on traditional techniques that lack accuracy. Ashbrook made a plea for new ideas and new inventions that would enable them to bring surface-instrumentation accuracies to underwater measurements.

Air Force Flight Test Center may have as many as a dozen active aircraft programs during the 1965-1970 time period, Maj. G. K. Patterson told the symposium. They included Dyna Soar, Bomber X, TFX, in-service VTOL, supersonic VTOL, supersonic transport, SOR 183 rescue system, global surveillance system, ZEL, X-15, B-70 and C-141.

B-70 Program

In the case of the B-70, just the most advanced of these projects, from the viewpoint of speed and distance covered, the present instrumented range would only allow 12 min. of true-to-flight time. Then the B-70 would have to be turned and brought back into a stabilized flight path again to enter the gate at the end of the range under equilibrium conditions.

Patterson said that AFFTC expects to extend its microwave link to Wendover AFB, Utah, in 1967, and south to the Pacific Missile Range and El Centro, Calif., in 1964. The northward leg would be continued to the Canadian border about that same time. This, said Patterson, would enable the B-70 to fly for 30 min. in a straight line path over the complete instrumented range.

He indicated that the Center was going into S-band telemetry, just as the other ranges are doing. But his added requirement was for two to three decibels noise in both S-band ranges, and for immediate real-time data on both pilot and vehicle.

Diagnostic Data

Critical biomedical diagnostic data is the major aim of bioastronautics specialists, who were represented at the symposium by Lt. Col. J. J. Rosa, assistant deputy for bioastronautics at Headquarters, Air Force Missile Test Center. Rosa presented his case built around the stated need to monitor, command and control almost every portion of a man-machine flight. He described a "world-wide, multi-purpose space flight command, control and guidance center that would determine the need for abort or recovery, would alert recovery or retrieval units, control the man-vehicle relationships and monitor range safety, all in the biomedical sense."

Specifically, he asked for these features in future manned space flights: completely redundant voice communication, television viewing of the subjects, preferably in color, at least one, but no more than two, physiological barometers such as an ophthalmoscope, in a measurement of eye flicker, blood pressure, or heart rate, baseline information from a complete display in real time of the environmental control system so that reactions could be related to environment.

Atlantic Missile Range

Accuracy of Velocity Data During Injection Phase

Requirement	1962 Capability	Future Capability
0.05-0.5 fps at 100-300 naut. mi. alt.	20-200 fps	1 fps
2-5 fps at 20,000 naut. mi. alt.	None	5-10 fps

NASA Names Head Of Applications Office

Washington—Morton J. Stoller has been appointed director of National Aeronautics and Space Administration's office of applications, a post which he held in an acting capacity since the agency reorganized last November (AW Nov. 20, p. 71).

Other changes in the basic organization made early this month include division of the public affairs office into four separate groups, completion of the organization of the tracking and data acquisition office, and appointment of several persons to serve in program offices.

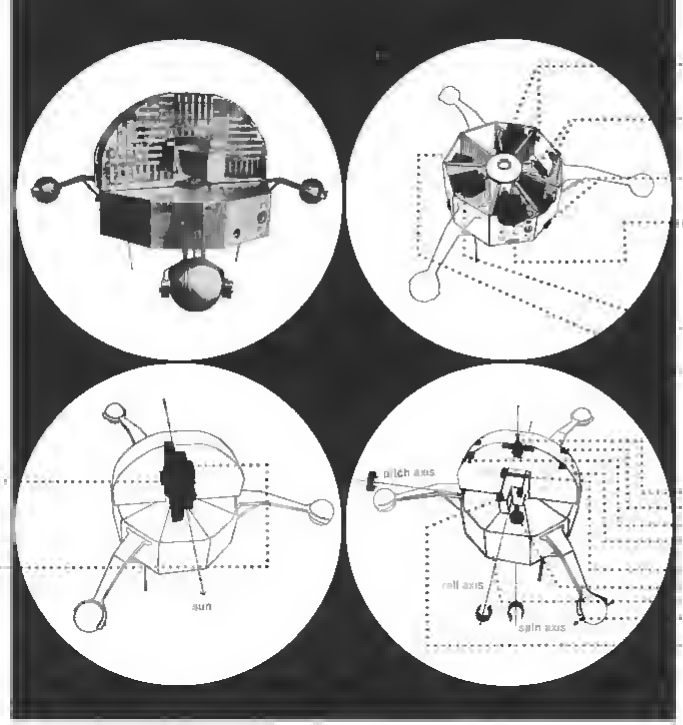
Joseph F. Shea has been named deputy director for systems in the office of manned space flight and James E. Sloan was appointed director of integration and checkout in the same office. Sloan's is a new program office in manned space flight.

Dr. Orr E. Reynolds is new director of bioscience programs in the office of space sciences, and John L. Sloop is director of propulsion and power generation in the office of advanced research and technology. Both program offices have been vacant.

The office of tracking and data acquisition now consists of a senior scientific representative for Australia, Edwin P. Hartman; national range support chief, Victor W. Hammill; program coordination chief, David Williamson, Jr.; and director of network operations and facilities, H. R. Brockett. A vacancy currently exists in directorship of program support and advanced systems.

Public affairs function, headed by Assistant Administrator Hiden T. Cox, consists of offices of public services and information, O. B. Lloyd, Jr.; educational programs and services, Shelby Thompson; scientific and technical information, Melvin S. Day; and program development, Harold L. Goodwin.

Key vacancies exist in directorship of advanced research and technology, and directorship of future applications. Thomas F. Dixon, deputy associate administrator, serves in a dual capacity as advanced research director.



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The recently launched Orbiting Solar Observatory is the first of a series of satellites to intensively study the electromagnetic spectrum from visible light through energetic gamma. From these investigations knowledge of the Sun's composition, Earth-Sun relationships and celestial phenomena will be greatly extended.

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SEPARATED HEMISPHERES of Telstar communications satellite reveal inner frame structure. Canister containing most electronic components is suspended inside skeletal housing in center frame. Slotted equatorial ring is broadband antenna.

Telstar to Check Radiation Effect On Payload Functions, Components

Bell System's 170-lb. Telstar active communications satellite, scheduled for launch shortly by the National Aeronautics and Space Administration, will include extensive instrumentation and telemetry for determining the effect of Van Allen radiation on component life and payload operation.

The first Telstar satellite and associated ground stations will have capability of transmitting 600 voice channels or one television signal in one direction. The satellite has capacity to handle 60 simultaneous two-way voice conversations but tests will be limited to 12 simultaneous two-way conversations because of present ground station limitations.

The new Bell System ground station at Andover, Maine (AW Feb. 12, p. 75), will transmit a signal to the satellite at 6,390 mc., which will be converted to frequency of 4,170 mc. and transmitted back to earth where it will be received both by the Andover facility and by a smaller Bell System station at Holmdel, N.J.

The satellite will be powered by 3,600 solar cells mounted on the vehicle skin, charging 19 nickel-cadmium batteries. Initial output of solar cells is expected to be about 15 watts, falling off to about 11.5 watts during 17-month period due to effects of Van Allen radiation and micrometeroid damage.

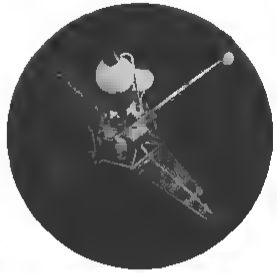
The satellite avionics payload totals about 15,000 components including 1,064 transistors and 1,464 diodes. The only tube used is a thin traveling wave tube to provide broadband final stage amplification for the satellite transmitter. The payload is housed in a 20-in. aluminum canister which is suspended from the satellite frame by means of nylon cord to provide isolation from shock and vibration. The canister is equipped with a thermally controlled lid designed to automatically open and close to maintain internal temperature.

Radiation Experiments

The major question which the Telstar satellite experiment will help answer is the operating lifetime which can be expected from a communications satellite, which in turn will be a major factor in the cost of implementing a commercial system. The radiation measurement capability built into the first Telstar satellites is expected to provide more complete information on the effects of Van Allen radiation than any previous satellite experiment, according to Bell System officials.

To measure energy levels of particles in the Van Allen belt, the skin of the Telstar will mount four special silicon diodes developed for this purpose by Bell Telephone Laboratories. The electrical response of each diode is directly

space systems



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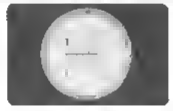
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proportional to the amount of energy a radiation particle loses as it strikes or passes through the diode.

Three of the diodes intended for counting and measuring energy of protons, each will carry different shielding and be biased to measure a different energy range: 4 to 10 mev., 12 to 25 mev., and above 40 mev. The fourth diode will count and measure energy of electrons.

Sample Solar Cells

Telstar is also designed to monitor the performance of three sample solar cells and six silicon transistors under exposure to Van Allen radiation. The short circuit current of each of the three solar cells protected by different amounts of shielding, will be telemetered back to evaluate the degradation in performance with exposure. The six transistors, each designed to be especially sensitive to radiation, will be mounted on the skin in pairs, each pair shielded by a different amount. Their outputs will be telemetered down along with the output from a seventh reference transistor which has been exposed to radiation on the ground prior to launch.

The experimental Telstar satellites will telemeter this and other data on payload performance and environment using a 3 watt transmitter operating at 136 mc. A total of 115 items will be monitored, including temperature of satellite skin, pressure inside the antenna chassis, amount of sunlight being received at several points on the skin, and the currents and voltages at key points within the payload transmitter-receiver.

Transmission Data

Telemetry data will be transmitted, upon receipt of a coded command signal from the ground, using a frequency modulation of a 3 kc sub-carrier which is used to amplitude modulate the 136 mc transmitter output. During transmission each measurement will be reported once every minute. When telemetry is turned off, the 136 mc transmitter will broadcast a continuous wave signal for use in tracking the satellite.

During launch, the satellite will use two small whip antennas at the base of the satellite for telemetry. Once the vehicle is in orbit, helical antennas atop the satellite will be extended to serve this purpose. Two omnidirectional antennas around the equator of the 34½ in. satellite will serve for reception and transmission of voice and television signals.

American Telephone & Telegraph has built four flyable models of its Telstar satellite, in addition to a number of non-flyable models constructed for ground tests.

Explorer 9 Reveals Atmospheric Changes

Washington—Explorer 9 inflatable satellite is returning atmospheric density readings which differ significantly from 1956 and 1959 ARDC model atmospheres, but the differences are being attributed to the decrease in solar activity as the 11-year solar cycle approaches its period of minimum activity.

The 12-ft. sphere has established, after detailed analysis, that at an altitude of 420 mi., the atmosphere has a density of 3×10^{-17} grams per cubic centimeter, about 40 million million times less than density on the earth at sea level. The 1959 ARDC model atmosphere, derived from high altitude balloon flights and extrapolated to 420 mi., shows a density of 3×10^{-16}.

Variations in measured density have been correlated with the 27-day rotational period of the sun and reflect drag characteristics caused by solar storms last April and August.

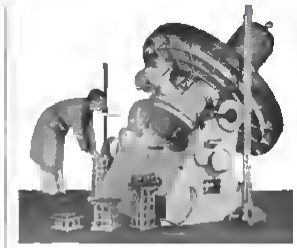
The 14-6 lb. sphere was launched Feb. 16, 1961, into an orbit ranging from 1,605 to 395 mi. Elements are now 1,510 x 469 mi. It has an estimated lifetime of at least two more years, when it is expected to spiral slowly down to denser layers of the earth's atmosphere. Scientists hope to obtain detailed readings of atmospheric density and drag effects to altitudes as low as 100 mi.

In addition to its geodetic measurements, Explorer 9 is providing information on behavior and potential lifetimes of low density satellites at altitudes at which it is orbiting.

Eglin Space Probes Measure Air Density

Seven-inch long sphere containing telemetry equipment and tumble-flight accelerometer was ejected from Nike-Cajun rocket at 200,000 ft. altitude over Eglin AFB 171 sec. after launch and continued up to 600,000 ft. As it descended, its relative deceleration caused by atmospheric drag was measured, beginning at 400,000 ft. The falling sphere technique is being utilized by Office of Aerospace Research's Air Force Cambridge Research Laboratories for atmospheric density research to determine re-entry angles of future aerospace vehicles. The technique was developed by the University of Michigan under AFCRL contract and a total of 22 launchers have been made.

Two Arcas-Robin rocketsonde vehicles also were launched from Eglin AFB the same day this month as the Nike-Cajun, to measure atmospheric density between 100,000 and 225,000 ft. Later launches were made by MATS Air Weather Service joint unit.



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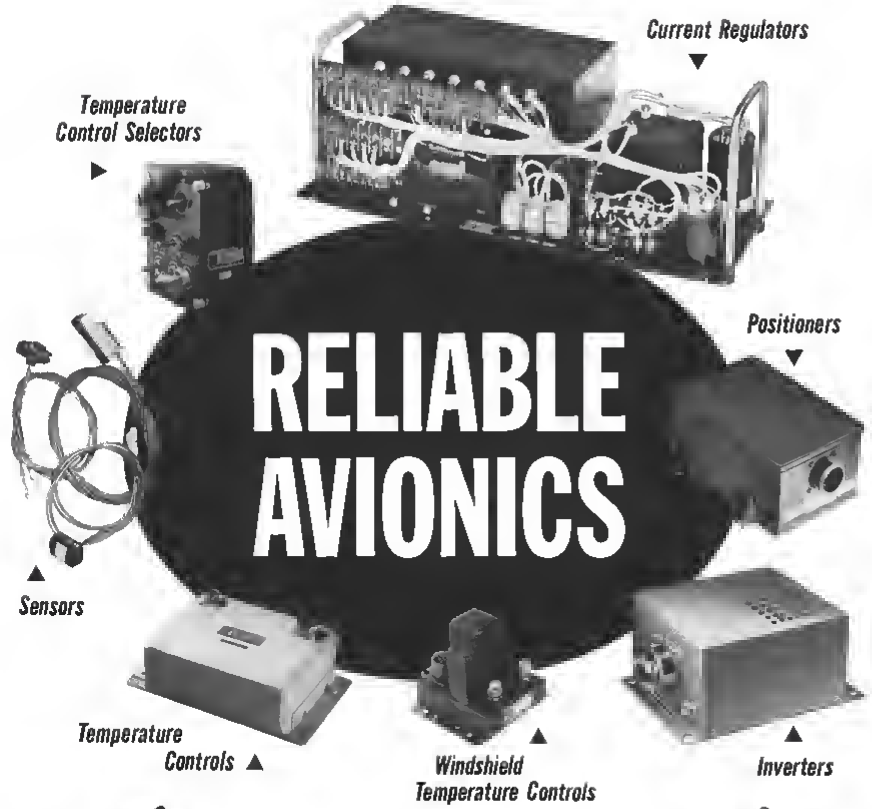
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PRODUCTION BRIEFING

Leach Corp., Azusa, Calif., will design, develop and manufacture a two-channel tape recorder-reproducer for the Discoverer satellite under a contract from Lockheed Missiles and Space Co. Device is to be capable of recording space data for three hours at a time and relaying it back to ground stations in about six minutes.

Flight Refuelling, Ltd., of Blandford, England, has signed a license agreement with Hayes International Corp. of Birmingham, Ala., calling for the British firm to manufacture a line of advanced Hayes tow targets for sale in England, Europe, the Middle East and the British Commonwealth.

Western Gear Corp.'s Precision Products Division, Lynwood, Calif., is designing and will manufacture the actuator system to control the horizontal stabilizer on the C-141 jet air freighter, now under development by Lockheed's Georgia Division for the Air Force.

General Dynamics Corp. has received a $7.6-million USAF contract to provide communications systems for Titan ICBM operational sites at Davis Monthan AFB, Ariz., McConnell AFB, Kan., and Little Rock AFB, Ark., and the Titan training facility at Vandenberg AFB, Calif.

Martin Co. has received a $500,000 USAF contract for development of fabrication techniques and design procedures for refractory metal honeycomb sandwich panels to be used in space vehicle construction.

Thiokol Chemical Corp.'s Longhorn Division, Marshall, Tex., will produce motors for Army rockets and missiles under a $3.9-million contract from the Army Ordnance Ammunition Command.

Electronics Systems Division of Air Force Systems Command has invited eight firms to bid on procurement of 35 weather radar cloud detector sets designed to provide cloud height data for Air Weather Service meteorologists. The companies are Acronex, Bendix, Cardion Electronics, Curtiss-Wright, Fairchild Camera and Instrument, Hazeltine, Olympic Radio & TV and Radiation Incorporated. Replies are due Apr. 2.

General Electric Co. next month will install a cryostat on a nuclear reactor at its Vallecitos Atomic Laboratory at Pleasanton, Calif., to simulate environment of outer space in relation to studies for use of nuclear powerplants for propulsion and electrical power. The refrigerator equipment will use liquid or gaseous helium in the irradiation test chambers of the 30-kw. reactor.

Ford Motor Co.'s Aeronutronic Division has received a $10,204,894 contract for continued development of the Army's Shillelagh surface-to-surface missile system.

Rocket chamber for USAF/Lockheed Propulsion Co. 120-in.-dia. solid rocket motor has been shipped from Excelco Developments, Inc. factory in Silver Spring, N.Y., where it was fabricated, to Potrero, Calif., for testing. One of the major purposes of the development is to test thrust vector control using fluid injection—probably reactive nitrogen tetroxide with inert freon possible as an alternate. Lockheed has been authorized to fill the case with Polycarbutene-R for feasibility studies and test firing.

Ionosphere sounding station, to be operated by the National Bureau of Standards, Boulder, Colo., to support upper atmosphere space probes, will be built at USAF's Air Proving Ground Center, Eglin AFB, Fla., during April and May.

First live ejection using new rocket-powered Martin-Baker seat was made at Chalgrove, England, recently by Sqdn. Ldr. Peter Howard, RAF physician, from a modified Gloster Meteor. Seat will be installed in third prototype of the Hawker P.1127 VTOL fighter, due to roll out this month.

Development contract for uprated version of Napier Gazelle free turbine helicopter powerplant of 2,000 shp. has been awarded to Napier Aero Engines by British Ministry of Aviation. Engine now powers the Westland Wessex and Belvedere helicopters.

Final arrangements to open a manufacturing plant at Mendoza, western Argentina, have been made by Cessna Aircraft Co. Ground-breaking ceremonies will be held later this month. New plant will initially build the Model 172 (AW Nov. 6, p. 93) under corporate name Cessna Argentina S.A.I.C., with initial aircraft rolling out this summer.

British Ministry of Aviation fuels research team, after a year's study of accidents involving airplanes using kerosene and wide cut gasoline (JP-4), recently said kerosene was the safer fuel in accidents where occupants survive the impact and also during fueling.

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SAAC 23 Success Hinges on Price, Early Availability

By Cecil Brownlow

St. Gallen, Switzerland—Swiss American Aviation Corp., in its drive to become the first on the market with a six-to-eight place lightweight executive jet aircraft, is pushing towards an initial flight date for sometime in May, with deliveries to U.S. customers beginning by late December.

To compress production and certification times, original plans to build two austere testbed prototype models of the 500-mph. SAAC 23 have been abandoned, and the first aircraft is now being fabricated on production line tooling, with another four scheduled to follow closely behind.

William P. Lear, Sr., SAAC founder and president, recently sold his holdings in Lear, Inc., for some $13 million, reportedly to ensure adequate capital for his new project (AW Feb. 19, p. 34). He also wants to spur sales possibilities by having two of his aircraft certificated and on the flight line at the annual meeting of the National Business Aircraft Assn. in Pittsburgh this fall.

Lear believes success of the aircraft as a commercial venture depends upon several factors, including early availability, price, reliability and relative simplicity. The fight to keep sales costs down is a major reason behind his willingness to risk a low profit potential for each unit to a point that pushes the breakeven point to approximately 400 aircraft. Still, eventual sales price for the majority of aircraft remains a problem.

SAAC originally had hoped to keep the U.S. cost of a stripped-down Model 23 to $250,000 plus another estimated $60,000 for full, all-weather instrumentation and $15,000 for a basic executive interior making a total of $325,000.

Swiss delivery price, however, has now shipped to a total of $350,000 for a fully instrumented aircraft with a more than basic executive interior, and Lear says he is not yet sure whether this figure can be held beyond the first 25 production models. "We're making every effort to hold the price at $350,000 beyond the first 25," Lear said recently, "but I may find that I will have to raise it to around $450,000."

One factor determining the final price beyond the first 25 aircraft undoubtedly will revolve around the resolution of the best possible, and available, means of marketing the aircraft in the U.S. and elsewhere.

Initially, Lear had planned to ship the SAAC 23 to the U.S. with only a minimum of instrumentation aboard and without an interior or its two rear-fuselage-mounted, 2,400-lb.-thrust General Electric CJ610-2B turbojet power plants. The aircraft would then have been assembled and mated to the engines at a central plant, with the individual distributor handling final instrumentation and interiors to meet the customers' needs and tastes (AW Apr. 17, 1961, p. 121). For at least the first 25 aircraft—for which Lear says he already has in hand firm orders or commitments at a guaranteed $350,000 price—the plan has now been changed. They will be assembled complete with interiors and full instrumentation by SAAC in Switzerland. The customer can either accept delivery here or pay the necessary ferrying charges to the U.S. or elsewhere.

Aside from the fact that no firm agreements with U.S. companies had been reached in time to handle initial orders and contracts, Lear says he has decided that he must retain strict control over the first aircraft off the line without any delegation of authority or responsibility to other parties.

One reason he cites is the necessity of keeping his work force intact without splitting off key personnel who would have to go to the U.S. for assembly and flight test trials, at least in the early stages, upsetting the balance here in the process. Another is that he wants to prevent the overloading of the airframe with unneeded equipment "so that it becomes a five-place rather than an eight-place airplane" until it has had the possibility of proving itself in the latter configuration.

In this regard, Lear, a pioneer in avionics, has made a survey of available instrument packages on the basis of reliability and weight and says he has saved 200 lb. on the selection of radio equipment alone.

He adds that he may still "eventually manufacture the airframe in Europe and then airfreight it to the U.S., where all accessory gear will be installed, including the APU [auxiliary power unit], radar, radio, engines, etc. We probably also will put in the interiors in the U.S. and ultimately sell the airframe stripped to the distributors" as originally planned.

There are two possibilities: construction of a new assembly facility—and Lear says he has received attractive offers on this score from a number of cities—or agreement with an existing manufacturer. "I had rather," he says frankly, "go into a plant that's in operation."

At least three U.S. aircraft firms have expressed great interest in adding the SAAC 23 to their lines, according to Lear. Obviously, if one is interested [to the point of an acceptable agreement] we would use their facility for assembling and possibly later in the manufacture.

Decision as to which of the two routes to follow probably will be made by the end of April, hinged upon the firmness and acceptability of the offers on hand at that time.

"The first 25 planes we are selling direct, and there's no problem," Lear says, but it is "inconceivable that we can sell 400 airplanes direct, so in order to get maximum merchandising cooperation we will have to work through an established manufacturer or through individual sales outlets" that already have a reputation in the executive plane field.

An obvious advantage of U.S. assembly of aircraft destined for American customers would be elimination of two-way shipping costs and possibly two-way customs charges on U.S.-supplied instrumentation, powerplants and other components. Lear hopes, however, to avoid any double taxation of U.S. equipment on which taxes have been paid prior to shipment to Switzerland.

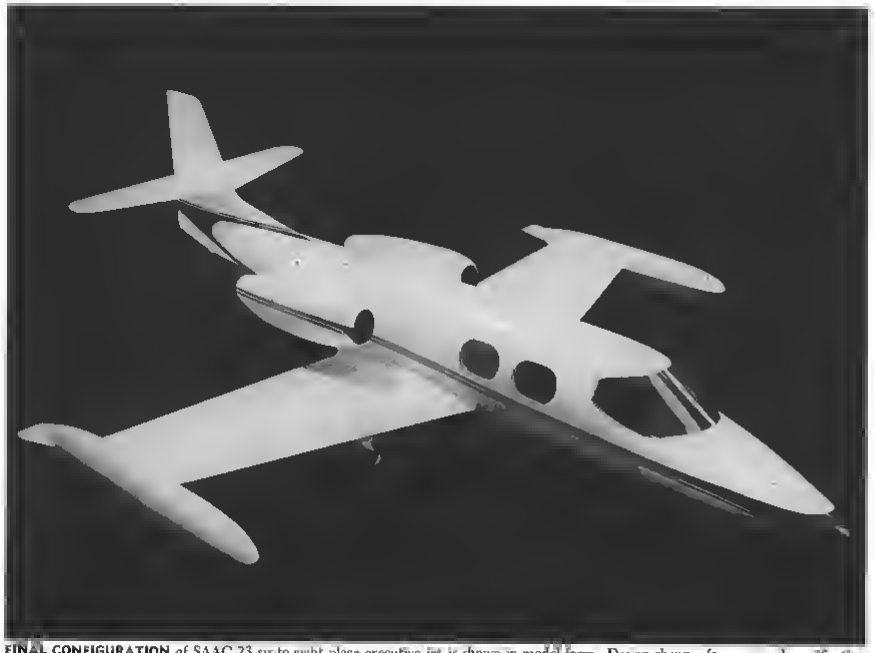
Of the first five aircraft off the line at the facilities of Flug & Fahrzeug werke A.G. in nearby Altenrhein, numbers one and two will be used for flight inspection and Federal Aviation Agency certification trials; three and four will be shipped to the U.S. as demonstrators; and number five will be delivered to the Department of Defense for evaluation at Edwards AFB, Calif., as a liaison and training aircraft.

When flight evaluation and certification are complete, the first two aircraft will be stripped of their test instrumentation and sent to the U.S. as demonstrators. Three and four will then be taken off the demonstration circuit, brought back to factory standards and delivered to the initial customers in December.

One and two, in turn, will continue to serve as demonstrators until February under present planning and then will be delivered to fill orders. In all, Lear plans to have at least two demonstrators in the U.S. for well over a year, rotating the aircraft as they come off the production line so that none puts in more than approximately 150 hr. in this category.

To build up time and experience on the engines, however, the powerplants probably will be switched from demonstrator to demonstrator with new units going into the aircraft prior to customer delivery. Initial period between overhaul of the CJ610-2B is estimated at between 800 and 1,000 hr., and Lear thinks this will improve substantially as operational experience is gained. Reported goal is at least 1,400 hr. between overhauls for the -2B.

The SAAC 23 will be certificated under CAR-3 for aircraft of normal category weighing less than 12,500 lb. and will include provisions for single pilot operation with or without a co-pilot. SAAC Chief Engineer Gordon Israel, who is pushing the program through to its completion, says the aircraft will substantially exceed all 3 requirements, meeting those of CAR-4B in most instances and probably go beyond estimated design performance figures by at least 5%. Guaranteed maxi-



FINAL CONFIGURATION of SAAC 23 six-to-eight place executive jet is shown in model form. Design changes from original specifications include conventional fixed horizontal tail rather than movable surface, plus addition of 23 in. to the fuselage length.



FUSELAGE NOSE will house radome unit plus other radar components, oxygen bottle and fittings. Access panels are located on both sides of the nose section. (Mockup shown.)



WING JIG in place at Flug & Fahrzeugwerke (FFA) facility. Trolley cars in left background are also part of FFA product mix.

mum speed, for example, is Mach 7.6. Israel believes it will attain at least Mach 8.

The certification itself will be handled by Swiss authorities under FAA direction and with an FAA designated pilot.

Under present programming for European manufacture, Flug & Fahrzeugwerke (FFA) is building the forward fuselage and wings, while Heinkel of Germany is producing the rear fuselage section, tail surfaces and engine nacelles. Landing gear, originally scheduled to go to Japan's Mitsubishi Heavy Industries, is being handled by Cleveland Pneumatic Tool Co. Final assembly is the responsibility of FFA under SAAC direction.

The final estimated specifications place the maximum speed at 588 mph. and the service ceiling at 45,000 ft. Cruise altitude is 35,000 ft., with normal cruise speed at that level listed as 500 mph. at a weight of 8,900 lb. and 90% maximum continuous thrust. Of the maximum gross weight of 11,800 lb., useful load is 6,350 lb., payload with a full 723 U.S. gal. of fuel aboard is 1,500 lb. Cost per passenger mile is estimated at a relatively low 6.7 cents, a figure below those for some twin executive piston engine aircraft.

Design changes that have been cranked in as the aircraft has progressed through its development cycle include adoption of a conventional fixed horizontal tail rather than a movable surface in order to cut costs, gain added stability and eliminate the need for a boost power control system; addition of 20 in. to the fuselage length between the wings and tail section to provide added cargo space and 12 in. between the cockpit and cabin door for increased cabin area. Final fuselage length is 40 ft. 7 in.; wingspan is 35 ft. 11.1 in.

At the suggestion of potential customers, two 20-by-27.5 in. oval windows for the cabin have been added to the one originally planned. Wrap-around double-paned stretched plastic windshield in the pilot's compartment provides a visibility sweep of 225 deg. All windows are stressed to withstand a pressure differential of up to 50 psi.

Fuselage of the SAAC 23 is of monocoque construction with ring-type frames fabricated from extruded sections, hydropressed sheet metal and machined forgings.

Skin is smooth contour flush riveted aluminum.

Eight-spar wing, which has a 13 deg. sweepback, is a 9% thick NACA 64-009 airfoil. Skin consists of single sheets of rolled aluminum alloy tapered in thickness from 0.110 in. to 0.071 in. on the upper surface. Lower surface has a constant thickness of 0.087 in. The conventional empennage is of similar structure. Tricycle oleo pneumatic landing gear unit can be extended manually by a cockpit pull cable which releases the restraining hooks in event of failure in the normal hydraulic system. Main gear is two wheel bogey, while the single nose wheel unit is steerable. For standardization and to provide a soft-field capability, all five wheels are of the same size with 18-by-5.5 in. tires. Track is 8 ft. 2.5 in., and brakes are hydraulically operated.

Designed for gust load strength factors of 6.3g, the aircraft can endure gusts of up to 25 fps at its 500 mph. cruising speed. Maximum allowable dive speed at an altitude of 7,400 ft. is 665 mph. TAS. Extension speed for the hydraulically operated wing-mounted flaps and landing gear is 225 mph. There is no speed limitation for extension of the speed brake units, one on the trailing edge of each engine support pylon, which, when extended, are designed to permit an 8,000 fpm. penetration descent from 40,000 ft.

Normal gliding ratio is 13:1 which, according to SAAC, provides a power off range of approximately 86 mi. from a 35,000-ft. altitude. The 27 lb. auxiliary power unit designed and built by Switzerland's Gebruder Sulzer A.G. can be cut in below 20,000-ft. altitudes to provide 200 amps. of emergency current for landing in a power-off situation.

The APU, mounted aft of the pressurized cabin in the aft fuselage section, also can be used to supply all the necessary ground power for heating, cooling and engine starts at airports where external power supplies are unavailable.

Fuel is contained integrally in the wing and tip tanks, feeding into the engines directly from the tip tanks. To provide maximum gust load alleviation, tip tanks are kept constantly full until the wing tanks are empty.

The cabin will be pressurized by bleed air from one or both engines to maintain a constant cabin altitude of 2,000 ft. at 25,000 ft., 6,200 ft. at the 35,000 ft. cruise altitude and 9,300 ft. at 45,000 ft. The pressurization system itself is being developed by the Astek Instrument Corp., Armonk, N.Y. (AW Feb. 19, p. 92).

Standard Instrumentation

Standard instrumentation for the aircraft SAAC plans to completely assemble here will include:

- Two VHF transceivers.
- Two glide slope receivers.
- RCA AVQ-20 weather radar unit with a 5½ in. nose-mounted disk.
- Two navigation receivers.
- Lear L-5C LIFE autopilot and integrated flight system.
- Lear L5B autopilot.
- Transponder.
- One DME-7 unit.
- Three RMI units.
- One marker beacon receiver.

Seven-place cabin mockup provides no feeling of being cramped or uncomfortable despite the aircraft's relatively small size—a maximum inside diameter of 4 ft. 10 in., a total volume for pilot and passenger compartment of 158 cu. ft. Interior provides side-by-side seating for three persons at the rear of the passenger compartment and two individual forward seats on rails just aft of the crew cabin which accommodates pilot and copilot. A jump seat can be added on the right side of the passenger compartment to gain the maximum eight person capacity. Toilet facility is housed beneath the right forward seat which slides forward.

The baggage compartment is located behind the three rear seats and has a volume of 41.5 cu. ft. As a cargo and/or litter carrier for military applications, backs of the three rear seats can be folded forward and the two individual seats removed from the cabin, providing an available space of 7 ft. 5 in. by 4 ft. 10 in. by 3 ft. 6.5 in.

In this configuration, cargo payload is 1,100 to-1,200 lb. at maximum range fuel load. As a litter bearer the aircraft can accommodate four passengers plus two medical attendants and flight crew.

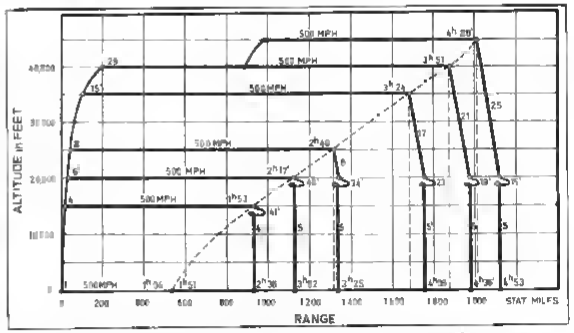
SAAC 23 Performance

(Estimated)

Max. speed at 10,000 ft	588 mph
Normal cruise speed at 35,000 ft	500 mph
Sea level takeoff distance over 50-ft. obstacle	4,100 ft
Sea level landing distance over 50-ft. obstacle	2,000 ft
Takeoff rate of climb at sea level	6,150 fpm
Service ceiling	45,000 ft
Normal cruise altitude	35,000 ft.
Maximum range at 40,000 ft	2,070 st. mi.
Empty weight	5,450 lb
Max. gross weight	11,800 lb
Passenger configuration	Max. eight persons
Cargo configuration	4,000 lb. over 750 mi. range



GENERAL PASSENGER and baggage compartment configuration as planned for aircraft completely assembled and fitted by Swiss American Aviation Corp. includes seating for seven passengers. Jump seat can be added. Stowable writing tables can be included in the design. Baggage compartment has a volume of 41.5 cu. ft. Maximum inside diameter of the cabin is 4 ft. 10 in.; total volume of the pilot and passenger area is 158 cu. ft.



RANGE of SAAC 23 is computed on basis of 500 mph. cruise speed carrying 723 U.S. gal. of fuel, seven persons and 310 lb. of luggage for takeoff weight of 11,800 lb.





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Steep Space Procurement Rise Predicted

New York—Projections that new procurement dollars in the field of space technology will rise in a steep, unbroken line from current levels to $8.5 billion annually in 1971 were described to the New York Society of Security Analysts here by Malcolm P. Ferguson, president of Bendix Corp.

The estimates, based on Defense Department program packages and Aerospace Industries Assn. figures, included military and civil space programs.

Missile and aircraft procurement will remain relatively constant through this era in the $4-6 billion range, Ferguson estimated. Aircraft after a drop early in the period, will rise again according to the projections, and then gradually taper off to about $4 billion in 1971. Missile dollars were projected to follow a fairly level path ending about $1 billion higher than aircraft.

In discussing the importance Bendix places on the space technology business, Ferguson told analysts Bendix was joining with Lockheed Aircraft in bidding on the Apollo lunar landing module. Lockheed is responsible for vehicle; Bendix for guidance and control.

A bidders conference is scheduled for late April or May on the module, though no firm date has been set. Request for proposals probably will be issued at the conference, which will be held at the National Aeronautics and Space Administration's Lewis Research Center at Cleveland.

Bendix also has quoted component prices to Martin-Marietta Corp. for the module, but not for full subsystems. General Dynamics/Astronautics also is understood to be a prospective bidder.

Ferguson also disclosed other space projects on which Bendix is bidding or devices it is developing:

- **Production contract** for the Massachusetts Institute of Technology developed guidance system for Apollo.
- **Launching connector cable** for Saturn, an $800,000 project.
- **Miniaturized chromatograph** for analyzing gases in a space vehicle crew compartment.

Bendix, which Ferguson said was fourth in 1961 in the number of NASA contracts handled and 13th in dollar volume, is prime contractor for the Army Advent communications satellite; has a communications contract in connection with NASA's Syncom, is developing an inertial guidance system for Saturn, and supplied environmental equipment and instrumentation for Mercury.

The year 1962 should be a good one for Bendix, Ferguson said, with sales running 5% ahead of the $758 million gross of the corporation last year, and operating profits also increasing. "But," he said, "the intangibles must be faced. The great game—the very costly game—of making proposals for major defense and space contracts is part of our lives."

Current earnings are not a source of much satisfaction to Bendix, partly because of the low level of profits on government contracts—especially cost-plus-fixed-fee research and development work. Bendix 1961 volume was divided 72% military and 28% commercial. Of its total business, 26% was missiles and space, 39% aviation, and all other military 7%. Of the total, 8% was commercial aviation, 14% automotive and 6% other industrial.

Some real hope exists that broader use of incentive-type contracts will improve profitability of military business, Ferguson said. "In dealing with the government," he said, "everything is on an individual contract basis. Although much of the work is done really on the very edge of the state of the art involved, which makes performance to a degree unpredictable, a military contractor is not permitted to average profits and losses except on renegotiation. You do not make up on the bananas what you lost on the apples."

Rising labor costs also are a factor, and so is company-funded R&D.

"Some of you may look at what you call the plateau of earnings on which we have lived the last few years and wonder how dynamic Bendix is," Ferguson said. "I prefer to point out that in passing through a period of profound technological change . . . Bendix has preserved its earning power reasonably well. We have not paid the price of this transition with a period of sharply reduced earnings."

Total engineering expense last year for Bendix was $142 million, and 40% of that figure—$52 million—was charged to Bendix's own operations. Capital spending last year, buildings and equipment, was about $16 million, and is estimated at $20 million this year.

Current backlog is $449 million, reported on the basis of funded portions of contracts only. The volume is largely on orders due for delivery during the year.

United Aircraft 1961 Profit Cut Blamed on High R&D Expenses

United Aircraft Corp. profits for 1961 dropped to $10,020,281, the lowest for the company since 1948, partly because of high company-funded research and development costs but also because of write-offs on electronics operations and unexpectedly high costs on some production aircraft and engines.

The 1961 earnings, a 0.9% margin on sales of $1,094,756,591, amounted to $1.35 a share, not enough this year as last, to cover the company's $2 common stock dividend. Dividends were maintained with the addition of $4 million from earned surplus to profits. Next year, the company predicts, earnings will improve enough to more than cover the $2 payment.

Company-sponsored research and development costs rose to $41 million in 1961 from $39 million the year before, and are expected to rise 10% further in 1962. Losses and write-offs were approximately a sixth of the R&D figure. These included:

- **High costs** encountered because of problems with the RL10 liquid hydrogen rocket engine built for the National Aeronautics and Space Administration.
- **Competitive price shaving** on certain hardware—probably including the HSS-2 twin-turbine helicopter and S-61L civil transport version.
- **Rapid introduction** into service of the TF33 military and JT3D commercial transport turbofan engines.
- **Termination and consolidation** of various electronics operations at the Hamilton Standard Division and at the Norden Division. These not only involved new products which appeared technically interesting but of little commercial value—and efforts such as that by Hamilton Standard to enter the missile ground-handling field—but also losses on contracts which failed to materialize. Hamilton-Standard lost potential environmental control system business for which it had invested funds when the B-70 was cut back to a bare airplane, and when Garrett Corp. won the Apollo environmental system.

Such conditions are always a part of operations, the report said, but were more severe last year than usual.

United also continued its substantial

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The mind focuses upon the center cube, each face having required a distinct cut Until that realization, the problem of proving that a minimum of six cuts is necessary to make twenty seven cubes out of one appears insurmountable Insight, perception, Achphenomenon at work

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spending for facilities in 1961, adding $33 million in fixed assets Establishment of United Technology to enter the solid booster business is a major item in this category Such costs will increase substantially next year, the report added

Earnings Decline

Sales, which were 77% military, increased $106 million over the 1960 total of $987 million Earnings declined $3,849 715 from the $13,868 996 of 1960

Two other major aerospace companies reported on 1961 earnings last week

• **Martin-Marietta Corp** reported consolidated sales of $1,213,183,713 and net earnings of $44,817 655 or $2 04 a share compared with sales of $1,019,335,044 and earnings of $41,283,897 or $1 91 a share for 1960 Aerospace sales for the merged company amounted to $830 million last year

• **Minneapolis-Honeywell Regulator Co** 1961 sales totaled $470,152,073 and earnings $24,945,845 or $3 48 a share For the previous year, the company earned $26,228,148 or $3 74 a share on sales of $426,183,310

Optimistic Outlook

Both companies were optimistic on the 1962 outlook, particularly in the military and space fields However, Martin did note the decline in business at its Baltimore, Md., plant because of failure of new programs to materialize as rapidly as expected Martin-Baltimore was an unsuccessful bidder on the Apollo lunar capsule won by North American Aviation

Financial Briefs

Aviation Growth Investments Inc., Silver Spring Md., has applied to the SEC for an exemption order under the Investment Company Act permitting Avemco Finance Corp to purchase 11 notes from the company at a price equal to their unamortized cost the commission issued an order giving interested persons until Mar 7 to request a hearing thereon Aviation Employes Corp owns all the outstanding stock of Aviation Growth Investments and 20% of Avemco Finance stock At Oct 31, 1961, the 11 notes to be sold bid unpaid balances aggregating $237,138.88 including aggregate unearned discounts of $47,869 61

Piedmont Airlines has completed the sale of $1,200,000 of 6% convertible subordinated debentures to four insurance companies trust accounts and institutional investors. The funds will be used for general corporate purposes and to increase working capital



THERMOSTAT PACKAGE PREVENTS POWER TUBE BURNOUT IN A 200 PSIG ENVIRONMENT

PROBLEM. The power tube in this case is both costly and delicate. Two conditions can cause it to burn out (1) if it isn't warmed up to 121°F before electrical load is applied, (2) if its temperature rises above 188°F. Pilot lights warn of both conditions The entire circuit of which the tube is a vital component is surrounded by a coolant fluid at a pressure of 200 psig. Prolonged vibration is also a factor "Creep action" thermostats had failed

SOLUTION: Two stacked KLIXON® M2 Thermostats, with potted leads terminating in a plug connector, have successfully solved this complicated problem

WHY M2 THERMOSTATS? Because they're the only thermostats with these four characteristics (1) the dependability of a snap-acting disc, (2) a temperature differential as narrow as 2° to 5°F, (3) a welded hermetic seal, (4) a switch-action option of opening or closing on temperature rise or drop ideal when both temperature control and pilot light operation are involved Other characteristics are charted below

IF YOU HAVE A SIMILAR PROBLEM, write for complete specifications, prices, delivery schedules and design assistance

PERFORMANCE CHARACTERISTICS OF M2 THERMOSTAT

Calibration	0 250°T Standard ±4°T on closing temp Special ±3°F on closing temp
Differential	0 250°T or 2 to 5°T; 251-350°F 5 to 9°T
Temp settings	—65 to 350°T; 350 to 450°T under development
Switch act on	SPST, closes on temp rise or temp drop
Electrical rating	250 000 cycles carrying 2 amps resistive 30 V-dc or 115 V ac
Dielectric strength	1250V rms 60 cycles for 30 sec
Vibration resistance	5 2000 cps at 15 G's avael or .036 D.A.
Leakage	Surpasses immersion test MIL-E 5272C
Approximate weight	5 6 grams

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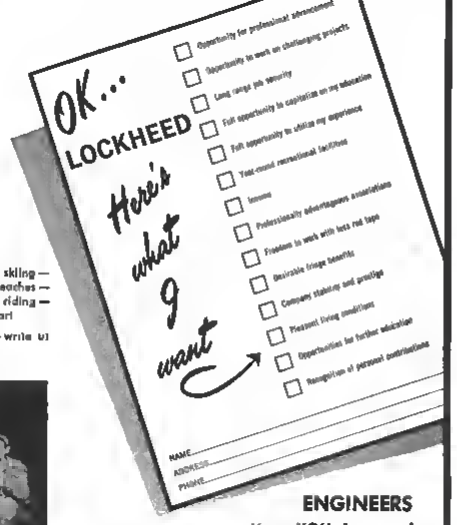
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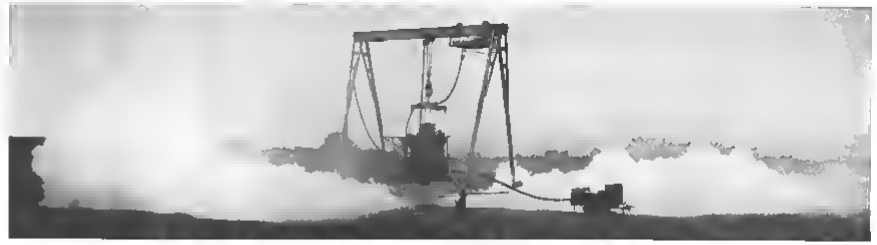
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GAS INGESTION of the Rolls-Royce RB 108 pure jet lift engine is checked by injecting hydraulic oil into the jet pipe and measuring the flow of the resultant smoke. Engine is hung on a gantry for series of ground erosion tests.

Rolls Studies Jet VTOL Erosion Effects

By Herbert J. Coleman

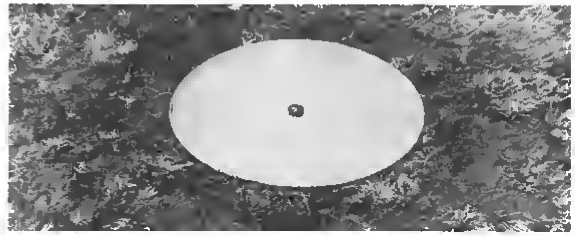
London—Rolls Royce research program into the problems of ground erosion caused by pure jet lift engines at takeoff and landing thrusts has led to exploration of operational use of light aluminum plates and varied treatment of concrete platforms.

In a preliminary full-scale program at Rolls' Flight Development Establishment at Hucknall, J. R. C. Fearon, deputy flight development engineer, and D. H. Noonan, technical assistant, came to these conclusions:

- **Lightweight aluminum** plates can reduce erosion of pasture-land, macadam and asphalt to negligible proportions during vertical takeoff regime.
- **Shortening** of the staying time over the surface has marked effect on reducing erosion. Surfaces will resist exhaust efflux of a single turbojet engine down to ground speeds as low as 10 kt.
- **Lowering** efflux velocity and temperature also reduces erosion. At efflux velocities of the order of 500 fps. the three surfaces would not require protection.
- **Amount of hot gas re-ingestion** in the single RB 108 pure lift engine used for the tests has been small. Air intake temperature rises of 3C were usual and never exceeded 8C. The RB 108 is the powerplant for the Short SC 1 and is the progenitor of the RB 162 series involved in several NATO entries for the VTOL fighter and transport competitions.

For forward area operational flying, Rolls devised a 2 ft. diameter plate with a ½ in. circumferential lip made from 10 gage aluminum and fitted with a center peg to affix it to the surface. Total weight was 6.1 lb.

Plate was still serviceable after 50 takeoffs. Another plate, made of 16 gage material, was good for only about 20 takeoffs.



LIGHTWEIGHT ALUMINUM plate devised by Rolls-Royce to resist ground erosion from pure lift engines operating in forward, rough-field areas, is shown after one takeoff cycle (top). Same plate is shown after 50 takeoff cycles (bottom).

Fearon said the plates are effective in protecting macadam and asphalt surfaces. A sheet of 24 gage (0.022 in.) aluminum fixed to the surface successfully withstood 50 takeoffs and provided adequate protection.

Fearon noted that to give scale to the weight penalty of this type of protection if carried aboard the aircraft in operating areas, these parameters prevail no matter how many lift engines are installed on the airplane.

- **Protection** by 10 gage aluminum plates is worth some 10 sec. of jet lift operations with all engines at maximum rating.
- **Protection** by 16 gage aluminum plates is worth some 6 sec. of jet lift operation with all engines at top thrust.

To determine ground erosion under STOL conditions, Rolls used a Gloster Meteor flying test bed, fitted with a RB 108 for taxiing purposes. Engine, mounted in the vertical position, gave a gas velocity at the nozzle of 1,750 fps. at maximum rating.

At speeds down to 10 kt. no damage to surface was encountered. Fearon attributes this to the low residence time directly under the nozzle never greater than 0.06 sec. Taxiing at speeds up to 40 kt. only loose fibrous dust from around grass roots was removed, and Fearon said this did not rise above 6 ft.

Another run was made on dry straw to test whether the Meteor was likely to start a grass fire. Straw was not burned or even charred, again due to low residence time.

For static testing, the RB 108 was mounted in a gantry for positioning over various ground surfaces. Entire

systems assembly could be raised and lowered from 7 ft to 1 ft over the ground. On the Meteor, the RB 108's nozzle was 30 in. above the ground.

Selecting a concrete hardstand at random and with the RB 108 positioned 3 ft off the surface, erosion was experienced after a single takeoff cycle. This was flaking to the depth of about 1/16 in. over an area of 2 ft. Fearon said it occurred because water, contained in small cavities in the top surface, boils under the jet blast and resulting steam pressure breaks off the flakes.

50 Takeoff Cycles

However, after 50 takeoff cycles, area of erosion had been increased by about 25%. Solution, Fearon thinks, is through use of "water-cured" cement for VTOL hardstands i.e., wet sand is placed over the concrete surface immediately after laying so that moisture is prevented from evaporating off the surface and it also is protected from fluctuations caused by the sun's radiant heat. Test stand laid by Rolls resulted in encouraging data, Fearon said, after more than 200 liftoffs produced no visible erosion at all.

Tests on a 2-in. layer of macadam on a concrete base, standard Ministry of Aviation hardstand specification, involved the single RB 108 positioned with the nozzle 3 ft. off the surface. After three cycles, the surface had been damaged over an area of 24 sq. ft. and about 2.5 cu. ft. of material had been removed, some of the pieces coming to rest as far as 80 ft. from the test rig.

Since protection of this surface was an obvious necessity, Rolls began a series of RB 108 runs to determine the flow pattern of exhaust gases beneath the nozzle during steady running. Engine was set up with the nozzle two diameters above an 8 ft. steel plate; under steady running, a traverse of the dynamic pressure of the exhaust gas flow along the surface was obtained. This was related to the dynamic pressure at the nozzle to obtain the "scrubbing velocity" at the ground surface.

Fearon discovered that the total depth of flow was about 3 in. and that it remained fairly constant with distance from the jet axis. This confirmed a suspicion that large and rapid mixing occurred as the flow spread out radially over the surface and a downdraft of cool ambient air was induced over the gantry.

However, at nozzle diameter from the nozzle axis, Fearon found that the flow was "sensibly" parallel to the ground and peak dynamic pressures (the "scrubbing velocities") occurred within the first ½-in. above the surface.

Measuring the surface temperatures over a water-cured concrete specimen hardstand, Rolls set up the engine nozzle 3 ft. off the surface, ambient temperature was 9C and maximum jet pipe temperature was 620C.

Test showed the maximum temperature immediately below the nozzle axis was 360C and, because of the large amount of mixing the temperature fell off rapidly. Three feet from the axis the surface temperature was down to 100C. At 6 ft. from the axis, surface temperature had dropped to 50C.

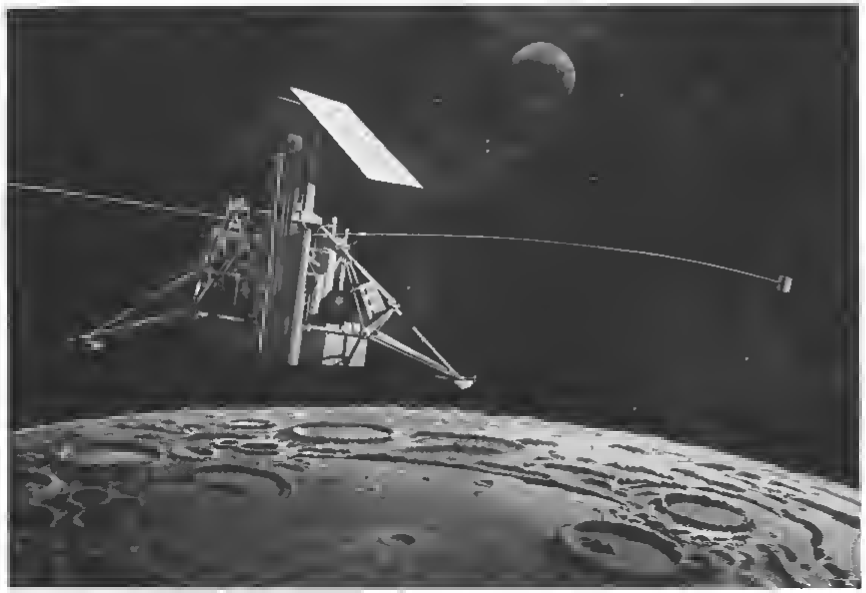
Intake Temperature

Another test phase centered on measurement of any rise in intake temperature due to recirculation of the exhaust gases. Flow pattern was obtained by injecting hydraulic oil (DTD 44D) into the jet pipe and photographing the resulting white cloud with motion picture cameras. Flow patterns were read off the film by using a Benson-Lehner coordinate plotting machine.

Parameters explored in reingestion tests included:

- Startup and steady running at idling speed.
- Steady running at maximum speed.
- Simulated takeoffs.

Problem for you:



Soft land this vehicle on the moon

This spacecraft is SURVEYOR, one of the many important projects now under way at Hughes. It will "soft" land on the moon sometime in 1963. Its mission: to pierce and analyze the moon's surface, to transmit back to earth high quality television pictures, and to measure the moon's magnetic and radiation characteristics. To accomplish these demanding objectives, Project Surveyor requires the talents of many imaginative junior and senior engineers and physicists to augment its outstanding staff. A degree from an accredited university and U.S. citizenship are required. Experience in Aerospace Vehicles is preferred but not necessary. A few of the openings include:

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CIRCUIT DESIGNERS. Involves analysis and synthesis of systems for telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

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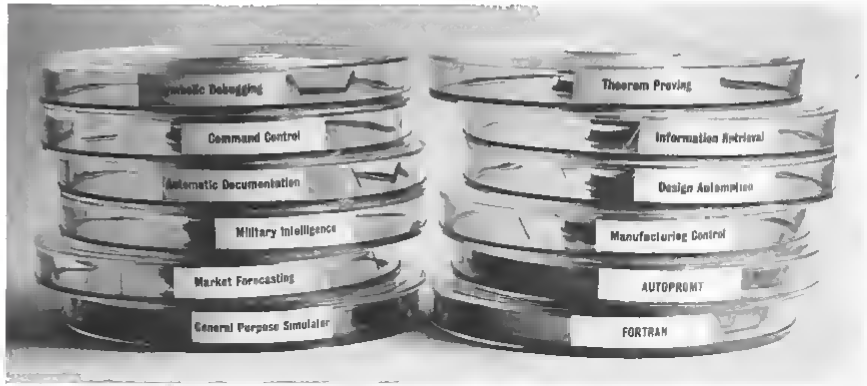
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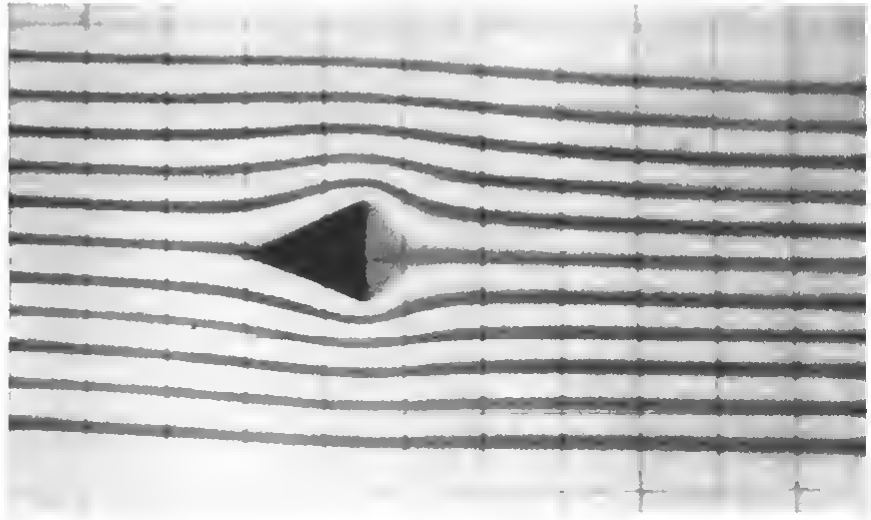
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PROBLEMATICAL RECREATIONS 111



Given five points in or on a unit square, prove that at least two points are no farther than $\frac{\sqrt{2}}{2}$ units apart. —*Contributed*

Among the multifarious displays open today for IRE 1962 you'll find Litton booths #1610-18 and 1709-17. Ten in all to give a representative look at the latest in Litton components. Products to be shown number in the hundreds. Probability is high that you'll spot several items for which you may have a direct application.

ANSWER TO LAST WEEK'S PROBLEM. Let A, B, C, D be any 4 of the points. Let them be so ordered that ABCD is a polygon. Then the lines AC and BD are uniquely determined and they form one intersection inside the circle. To each set of 4 points there corresponds a unique intersection within the circle. Hence there are $C_{n,4}$ or $\frac{n(n-1)\,(n-2)\,(n-3)}{4 \cdot 3 \cdot 2 \cdot 1}$ such intersections.

LITTON INDUSTRIES, INC.
Beverly Hills, California

LETTERS

Nimbus Paddles

Reference is made to your issue dated Jan 22 I would like to clarify a widespread industry misconception concerning the Nimbus meteorological satellite Early ads in trade publications plus the cover picture of your Jan 22 issue let the reader infer that General Electric has prime responsibility with NASA for this satellite design This fact is far from the actual truth Your article on p 54 does a fine job in defining Nimbus responsibilities

Specifically, I take exception to the front cover photograph of Nimbus solar cell dummy paddles extended, with a GE emblem glaringly plastered on them

For the record, the Radio Corporation of America Astro Electronics Division, designed and developed the actual large solar collectors These paddles are rather an advanced state-of the art design 24 sq ft of active collector surface with a weight of approximately 0 9 lb per sq ft for solar cell and collector combined

Also, for the record, the vendors responsible with RCA for these paddles are Goodyear Aircraft, Akron Ohio which fabricated the structure of the paddles to our specifications and International Rectifier, El Segundo Calif , which is supplying the solar cells to RCA specifications

SEYMOUR H WINKLER Program Manager
Nimbus Solar Power Conversion System
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Design Integration Space Power Section
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Astro Electronics Division
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Princeton, N J

Job Insecurity

An informed scientist could hardly take serious issue with your current appraisal (AW Jan 15, p 115) of government ability to staff its technical agencies Your article did not emphasize several of the aspects of this grave the government has been steadily digging for itself ever since World War 2 When I first took a job the rewards and prestige of civil service were worth competing for Now there are many reasons for preferring private industry

One strong deterrent from government service is the 1944 Veterans Act which was intended to restore jobs to veterans and continue their 5% advantage over non veterans competing for jobs Its application as super seniority without consideration for capability The writer was bumped from a 14 year technical career by a veteran with a few months in a related job In another few months he left to try something else A non veteran scientist should never plan far ahead for government career service if he needs a steady job

There is too much confusion about the qualifications for the various pay grades Back up the road the Civil Service Commission described the jobs and graded the applicants with some uniformity Now many agencies have their own private job registers or even hire without any organized competition This is fine in private industry but contrary to the rules established by taxpayers NASA could offer an engineer a GS 14 certification while the Bureau of Standards Radio Labs would offer a GS-12 for similar work and refuse to grade an application for higher levels

Things will not get better until the non veteran is again attracted to government jobs and the Civil Service Commission insists on open competition for jobs

D E CULNAN
Electronic Engineer
The Lionel Corp

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Safety Precautions

It is indeed ironic that the crash of the American Airlines 707 jetliner occurred only an hour before the welcome given by New York to Lt Col John Glenn Never to my knowledge have so many precautions to insure the safety of one man been taken as in Project Mercury, and nowhere have safety precautions for thousands upon thousands been so consistently disregarded as at Idlewild Airport

For many years the Port of New York Authority has forced the airlines to operate their aircraft at less than maximum safety in order to reduce the "noise inconvenience" to nearby residents or be liable to penalties and fines

Takeoffs are from a short runway over the bay rather than from a longer safer runway over the city with the wind away from the city, rather than into the wind and over the city and with noise suppressors which cut down vital engine power Departures are made with less than optimum fuel load (with consequences which may be felt only many hours and many thousands of miles later) and at a low speed with a high rate of climb and with quick turns near the ground again to get away from the city as quickly as possible As a pilot I shudder at the thought of a takeoff—in any airplane—under such conditions

Above all, a pilot must get and keep control of his 120 ton airplane and control requires first of all speed Speed, control, and safety are gained only by violating the regulations of the N Y P A Since airlines are marginally profitable, at best they have but little choice

The groups who are most vociferous about the noise problem may say that such takeoffs are "only a little less safe" Yet only a "little less safe" compounded over the many tens of thousands of jet departures from Idlewild over the last five years, may at last have culminated in disaster

I am not suggesting that unsafe practices were the sole reason, or even a major reason, for this crash That is for the CAB to determine I have been closely associated with aviation for many years, and have yet to know of an accident which was not caused by a chain of many little factors which contributed to the pilot's inability to cope with a major emergency Perhaps this was such a case

In any event it is only a matter of time until blame for an accident at Idlewild can be laid directly at the doorstep of those who are unconcerned by the noise unless immediate steps are taken

First the flying public should boycott any airline which does not publicly announce its adherence to maximum safety practices Secondly, the pilots themselves, through the Airline Pilots Association should consistently refuse to make substandard departures And finally, those whose lives are at stake should through press, radio television and letters to the airlines make their voices heard

John Glenn deserved and got, the ultimate in safety precautions, no one would have it otherwise Certainly the flying public deserves the same consideration

CHARLES L BAKER
Bethesda, Md

Minority Opinion

The panel of scientists discussing the role of man in space at the Air Force Office of Scientific Research/IAS Second Annual Astronautics Symposium in Denver in April of 1958 did not unanimously denigrate this role (AW March 5 p 13) A strong minority opinion to the contrary was held by the only AFOSR member on the panel, Col Paul Campbell, MC USAF, then Assistant for Medical Research to the Commander, AFOSR now Assistant for Advanced Studies, Aerospace Medical Center, Brooks AFB, Texas

KNOX MILLSAPS
Executive Director
Office of Aerospace Research
United States Air Force
Washington D C

Old Workhorse

As a manager of one of the airlines contracted to the United Nations in the Congo, I read Mr Alexander's article in your Jan 29 issue (p 96) with interest

The poor ground support situation which was mentioned in the article, and which would be prevalent in any other remote area where a UN force would be needed, has developed a point which was not mentioned in the article but which is significant The workhorse of the UN logistics operation within the Congo has turned out to be the DC 4 Experience has taught that where sophisticated equipment cannot be relied on due to lack of supply, ground equipment, adequate runways and communications, the unsophisticated old C 54 keeps going and gets the job done

Interocean Airways has been operating within the Congo for over a year and is presently flying eight DC 4s approximately 200 hr per aircraft per month

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MAR. 27 1962

حياة طويلة



This Arabic script means "Long Life." For people who deal with complex microwave problems, "long life" means Varian klystrons—pulse, CW, reflex.

Simplicity of design, ruggedness, and precision manufacture make possible these histories: On Spruce Mountain, Nevada, a VA-220 reflex oscillator klystron was installed in 1956 in a TV transmission system. It has been operating unattended for more than 33,000 hours. Near the Arctic Circle, VA-842 super-power klystrons were installed in 1956 in a classified radar network. Eight tubes had reached 10,000 hours operation by December, 1961. In Norway, VA-800C CW amplifier klystrons were installed in 1958 in HOTLINE, a link in a NATO troposcatter system. Six tubes are still going after 10,000 hours; one has reached 20,000 hours. If your microwave system design calls for tubes that *last,* contact Tube Division.

VARIAN associates
PALO ALTO 22, CALIFORNIA

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